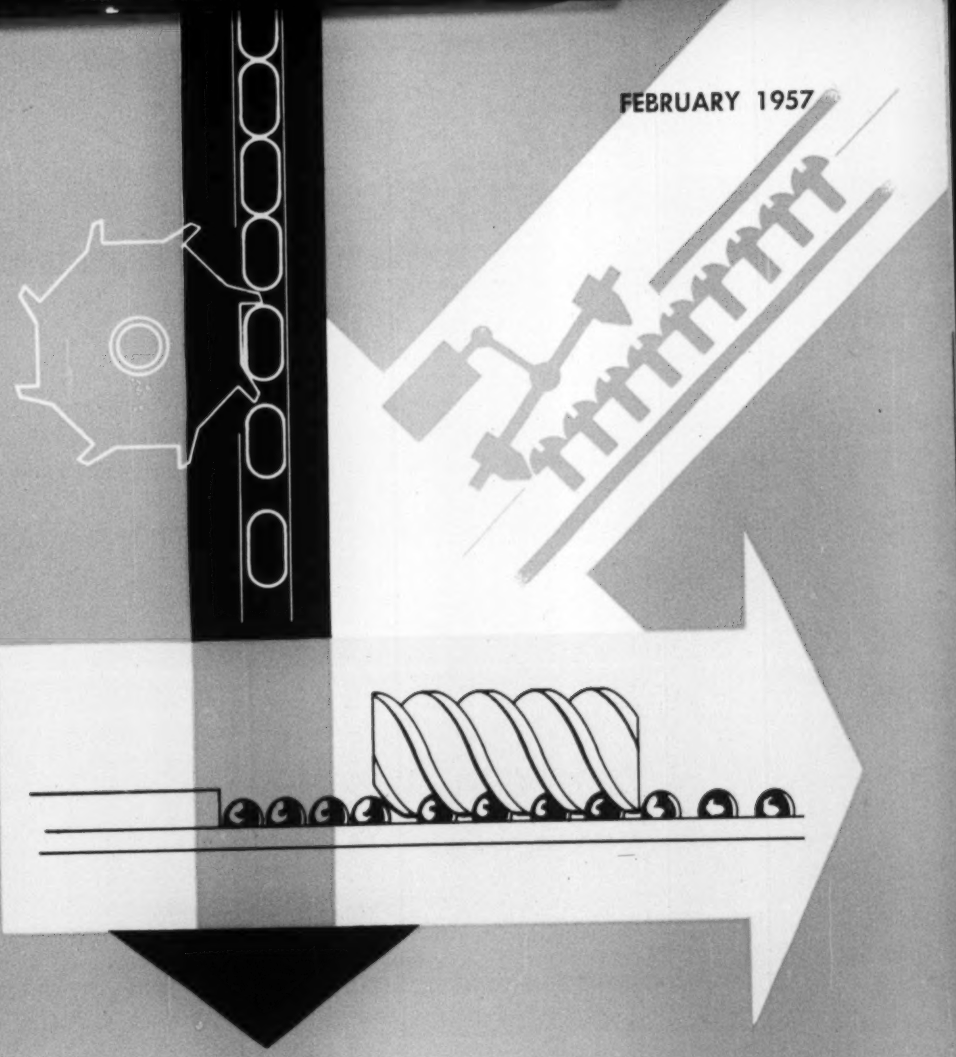
AUTOMATION

FEBRUARY 1957



Escapements

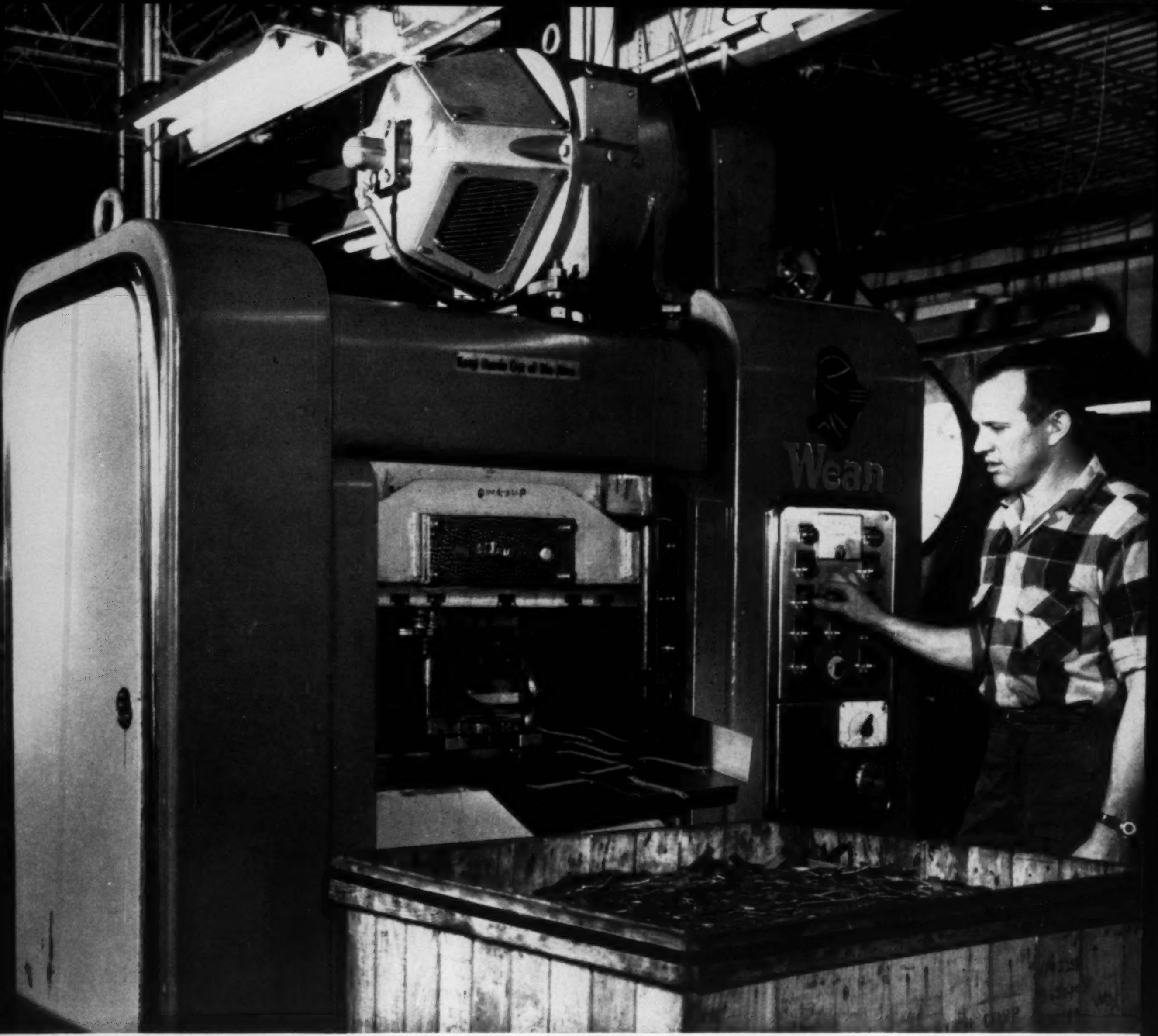
FOR AUTOMATIC EQUIPMENT

The Magazine of Automatic Operations

- **Manufacturing Engineering at Work**
- **Automated Engine Plant**
- **Electronic Reliability**
- **Automating Batch Heat Processes**

CONTENTS—PAGE 3

A PENTON PUBLICATION



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the fastest press in the world?

WE THINK IT IS. While our top speeds have stayed around 600 strokes per minute on the "flying press," the size of piece is not restricted to washers and the like which are made on other high speed presses.

For example, where conventional presses rarely can process more than 100 feet of metal per minute, the "flying press" has performed at speeds in excess of 300 feet per minute.

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We could write a book about the features of the Wean "flying press" — in fact we have. It's soon to be released . . . and it's yours for the asking. Write to the address below. We will mail your copy of the Wean "Flying Press" brochure as soon as it comes from the printers.

Wean Equipment Corporation
CLEVELAND 17, OHIO

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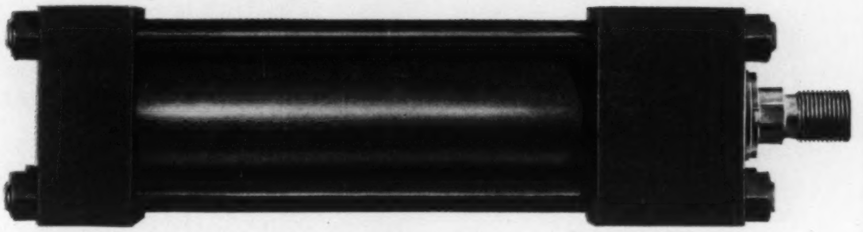

designed for leadership!

The superiority of Hannifin cylinders begins on the drawing board, where Hannifin designers have originated feature after feature not found in other air and hydraulic cylinders. But it doesn't end there...

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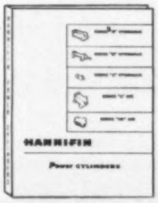

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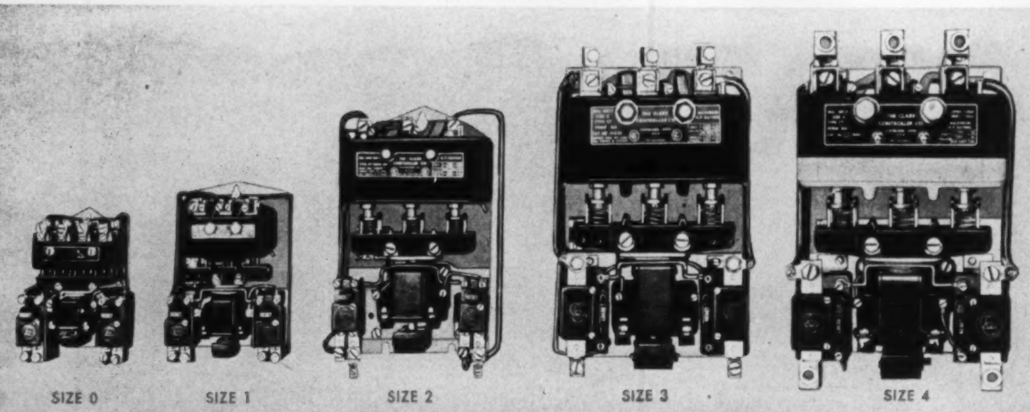

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0 to 4

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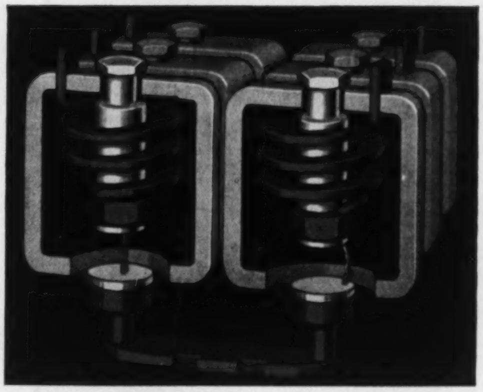

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FEBRUARY 1957
Vol. 4—No. 2

AUTOMATION®

The Magazine of Automatic Operations

A PENTON PUBLICATION

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EDITORIAL OFFICES
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Standing Still, 45
EDITORIAL—latest facts show wage rate increases outrunning productivity increases. More automation needed.

Manufacturing Engineering at Work, 46
L. J. MOELLER—case history of application of volume-production principles to making telephone cable terminals.

Tape Controlled Table Positioning, 53
NUMERICAL PROGRAMING—punched holes representing decimals sequence movement to successive machining positions.

Automated Engine Plant, 54
H. R. BENTLEY—AUTOMATION TODAY—considerations and principles used in establishing a facility for V-8 engines.

Automating Batch Heat Processes, 60
JAMES B. HENWOOD—automatically controlled production makes efficient use of manpower, energy, and space.

Stripping Coil Leads Mechanically, 66
INSULATION REMOVAL—proper preparation of leads is essential to obtaining reliable electrical connections.

Progress in Stamping, 67
W. D. BERRY—experience with automatic equipment in pressrooms brings to light design considerations.

Automatic Feeding, 70
BAR HANDLING—loading and feeding equipment speeds automatic centerless grinding of stock for Swiss-automatics.

Automatic X-Ray Inspection, 72
FLAW DETECTION—soundness of ammunition's explosive charge verified on computer-controlled six-station machine.

Electronic Reliability, 73
J. ROY SMITH—designed-in features of equipment provide for function, manufacture, utility and maintenance.

Escapements for Automatic Equipment, 80
KENNETH R. TREER—devices for regulating the release of parts or quantities of material in controlled amounts.

Timing Functions, 87
JAMES R. WALKER—part four—diagrams and descriptions of three circuits that make use of magnetic amplifiers.

REGULAR DEPARTMENTS

Automation Outlook, 4
Automation News, 9
Reader's Reply Card, 17
Meetings and Events, 28
Detroit Dateline, 33
Notes from Britain, 39
New Equipment, 91
New Components, 107
New Literature, 129
Abstracts, 133
Editorial Index, 142
Patents, 144
Books, 148

automation outlook

GREATEST ASSURANCE OF STABILITY

". . . the manufacturing industries which have gone the farthest in automation and the ones in which employment is rising the fastest. This includes the communications, electrical machinery, chemical, rubber, automobile, and petroleum industries . . . the dollars and cents of automation provide a further incentive to management to do the careful and long-range planning which is the greatest assurance of stability in employment opportunities. Automation compels us to tie into one package our plans for marketing, product design, manufacturing facilities, distribution and promotion, pricing, and above all, timing . . ."—*Ralph J. Cordiner, president, General Electric Co.*

CHANCE FOR SUCCESS

". . . complete automation of a factory or shop would certainly be an ideal accomplishment. However, there are many limitations that make it impractical or uneconomical to even approach such a utopian arrangement. Automation has its best chance for success in a mass production environment . . ."—*L. J. Moeller, assistant superintendent of manufacturing engineering, Point Breeze Works, Western Electric Co. Inc., see page 46.*

COST REDUCTION

". . . we believed that the best way to reduce costs in our engine plant would be to build the highest possible precision into the machinery and to equip the plant with automatic machine controls that would reduce to a minimum the possibility of error. The result would be reduced expenses for trouble shooting, maintenance and repair, reduced downtime for machines, and minimum loss from scrappage . . ."—*H. R. Bentley, manager, production planning, Engine Div., Chrysler Corp., see page 54.*

MORE CREATIVE TASKS

". . . small wonder, then, that scientists welcome the new tools that perform lifetimes of calculations in weeks or days and free them for more creative tasks. They would agree, I am sure, that technological unemployment is no more likely to occur in science as a result of computers and other automatic devices than it is in industry. Economists, scientists, and managers who have been studying the ramifications of automation agree for the most part that as automation develops, the need for higher and higher skills in our labor force will grow commensurately . . . even if we could reverse the processes of technology and automation, I am sure that in the final showdown we would not . . ." —*Alan T. Waterman, director, National Science Foundation.*

CROSS FERTILIZATION NEEDED

". . . with the urgency of needs in these areas, it is criminal for people to spend time rediscovering truths already known—to go through all the growing and application pains which have previously been gone through by someone else . . ."—*Thomas Roy Jones, president, Daystrom Inc., see page 9.*

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Published by

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Subscriptions in United States, possessions, and Canada for home-addressed copies and those not qualified under above rules: One year $10. Single copies $1.00. Other countries: One year $20.

Published monthly and copyrighted 1957 by Penton Publishing Co., Penton Bldg., Cleveland 13, Ohio. Accepted as Controlled Circulation Publication at Cleveland, Ohio.

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BPA NBP

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- drives from any position

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The famous Shakeproof Model "400" automatic power screw driver, perfect for bench type mass-assembly.

The completely self-contained new Semspak Power Driver feeds screws automatically, drives screws automatically as fast as you can pull the trigger. Screws are held tight and cannot leave jaws until started in work piece . . . no danger of "shooting" screws. Semspak Power Driver may be used anywhere for fast, completely automatic screw driving in metal, wood or plastic.

Semspak drives machine screws, wood screws, sheet metal screws, thread-cutting screws and Sems (screw and washer assembly) in lengths from 7/16" to 1½". It accommodates the following head styles: round, pan, oval, flat, fillister and hexagon heads, slotted or Phillips. Constant power is supplied pneumatically through a single lightweight air hose. Only eighteen inches long, Semspak weighs just six and a half pounds for complete portability and handling ease. Torque is quickly and simply adjusted and bits are changed in seconds without special tools. The Semspak visible-load cartridge holds up to sixty #8 or fifty #10 screws and is automatically reloaded from the jam-proof hopper.

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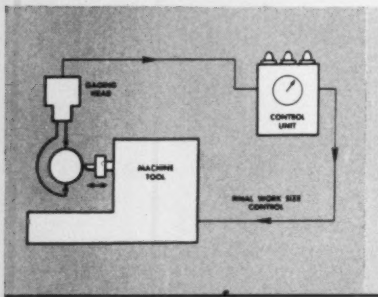
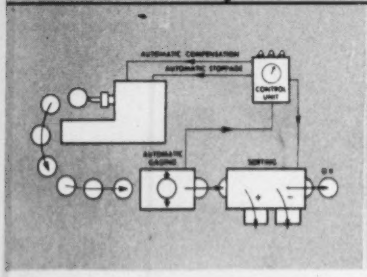
Why FEDERAL offers more

RELIABILITY THRU DIVERSIFIED EXPERIENCE

Diversity in Automatic Control



IN-PROCESS
control utilizes gage to make tool retract when part has been machined exactly to correct size.

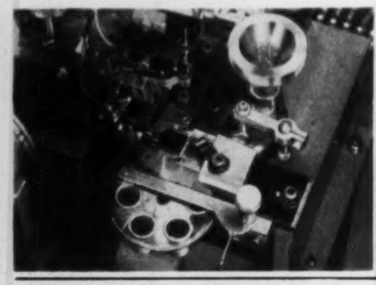


POST-PROCESS
control provides feedback of corrective signals from automatic gage to machine to maintain part uniformity. Federal pioneered both this and "In-Process" type of control.

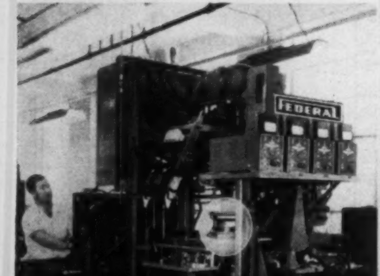
Any type of precision gage should be reliable, but when the gage becomes part of the automated process, reliability becomes of premium importance. There's a lot at stake. Over the years Federal has developed numerous ways to greatly increase Automation Gaging reliability. For instance . . . using extremely low voltage at sensitive switching contacts. This eliminates pitting, and tremendously prolongs contact life, maintains precision. And, Federal Automatic Gages employ electronic switching . . . vastly more accurate, faster, and more maintenance-free than the use of mechanical means to actuate work-handling relays.

You don't come by these features overnight. They are the result of hard-headed experience acquired in the designing and building of many diversified types of automatic gages. This extra reliability is bound to pay off. It's reliability which you not only can afford, but which *you cannot afford to do without.* And, only Federal provides it!

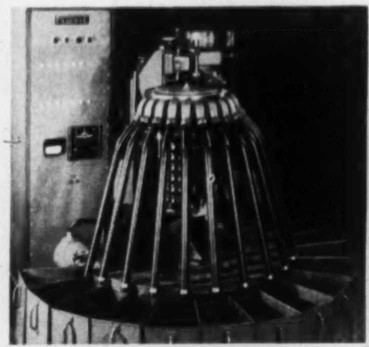
Diversity in Automatic Inspection



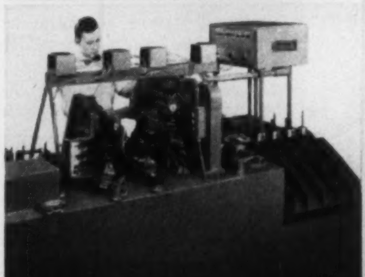
WATCH JEWELS
Each jewel is the size of a pin-head, yet this gage automatically handles, checks and sorts 1800 per hour! Gage measures hole in jewel only .008" in diameter.



TRUCK WHEELS
This Federal Gage automatically checks 500 massive truck wheels an hour for radial and lateral runout, sorts into good and bad.



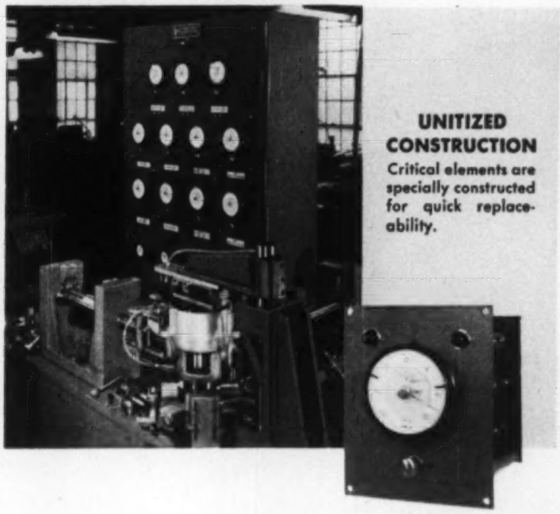
24,000 PIECES PER HOUR
This high speed automatic gage checks diameter of various size ball bearings, sorts into 12 categories of .000010" each!



21 DIMENSIONS
2400 per hour.
This gage is adjustable to automatically handle 13 sizes of turbine blades, measuring almost two dozen dimensions in only 4 stations.

in Automation Gaging!

SIMPLICITY THRU STANDARDIZATION



UNITIZED CONSTRUCTION
Critical elements are specially constructed for quick replaceability.

Automation will never become wholly standardized, but Federal — because it has had such long-time experience in this field — is able to meet most control and inspection demands using basic, standardized components. This means lower costs for you, for one thing . . . but much more importantly . . . it means greater reliability of performance. It means this too — much less dependence on technical talent and immediate service. Standardized units can be replaced with spares quickly and easily, should the need arise. What sizable savings in downtime costs!

This is the kind of common sense design you should have in return for your Automation Gaging investment . . . and Federal can give it to you. Ask your nearest Federal representative to come in and discuss this in terms of your own needs.

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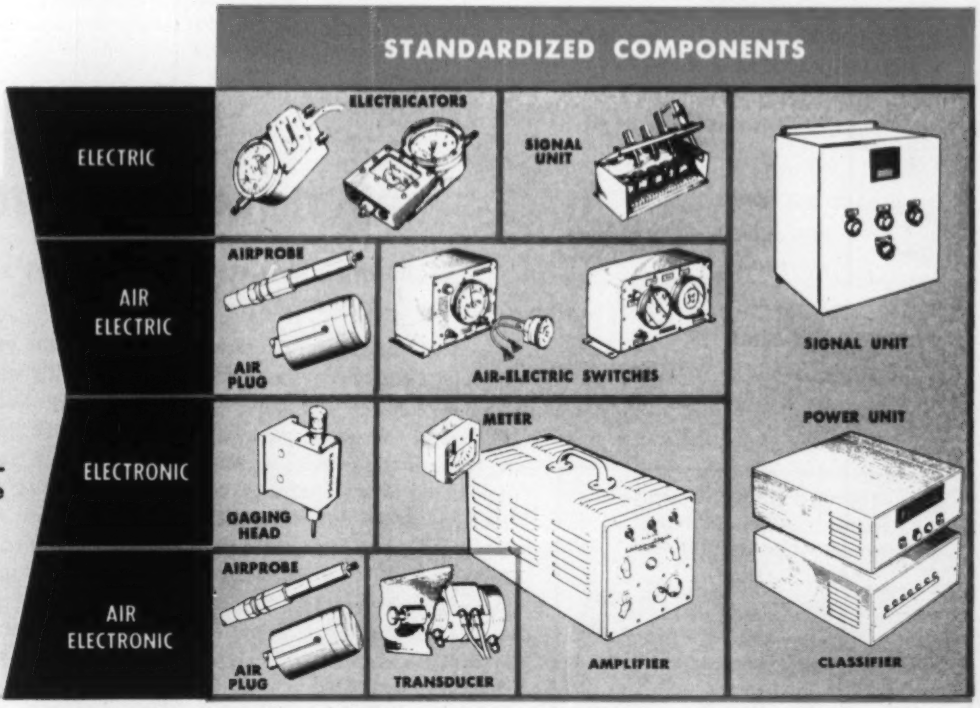
STANDARDIZED COMPONENTS
ELECTRIC
AIR ELECTRIC
ELECTRONIC
AIR ELECTRONIC
ELECTRICATORS
SIGNAL UNIT
AIRPROBE
AIR PLUG
AIR-ELECTRIC SWITCHES
SIGNAL UNIT
POWER UNIT
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GAGING HEAD
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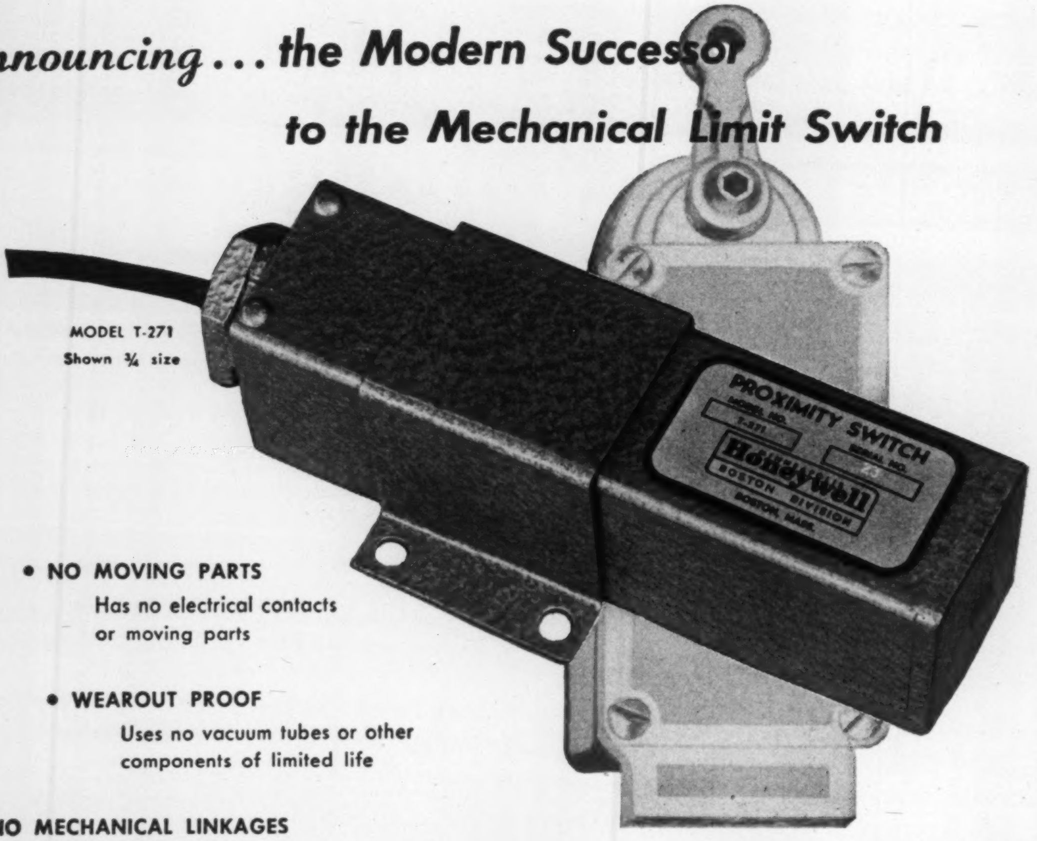
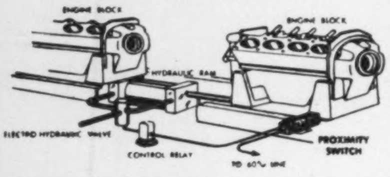

PROXIMITY SWITCH
MODEL NO.
T-271
SERIAL NO.
MINNEAPOLIS
Honeywell
BOSTON DIVISION
BOSTON, MASS.

MODEL T-271
Shown ¾ size

- **NO MOVING PARTS**
  Has no electrical contacts or moving parts
- **WEAROUT PROOF**
  Uses no vacuum tubes or other components of limited life
- **NO MECHANICAL LINKAGES**
  Requires no physical contact with workpiece
- **FAST RESPONSE**
  Will operate up to 10 times per second
- **POWER REQUIREMENTS**
  Conventional 115 volts 60 cycle source

TYPICAL APPLICATION

PROXIMITY SWITCH ACTUATING ENGINE BLOCK TRANSFER LINE


ENGINE BLOCK
ENGINE BLOCK
HYDRAULIC RAM
ELECTRO HYDRAULIC VALVE
CONTROL RELAY
TO 60~ LINE
PROXIMITY SWITCH

PROXIMITY SWITCH

MECHANICAL AND ELECTRICAL FAILURES ELIMINATED

The Honeywell Proximity Switch detects the presence of ferrous objects without requiring physical contact. It's a newly developed magnetic device containing no moving parts. Detection is accomplished as the object passes through a magnetic field set up directly in front of the switch's sensing head. The switch transmits an electrical signal which operates a control relay that may be remotely located. Many industrial automation processes are replacing the conventional limit switch with the newly developed Honeywell Proximity Switch to avoid work stoppages due to mechanical failure. Among some of these applications are switching operations in materials handling control and automatic machine tools. *Write for Bulletin PS* . . . Minneapolis-Honeywell, Boston Division, Dept. 00, 1400 Soldiers Field Road, Boston 35, Mass.

MINNEAPOLIS
Honeywell H HONEYWELL
BOSTON DIVISION

Circle 558 on Inquiry Card

AUTOMATION news

Today's events and developments in the field of automation

APPROXIMATELY 10 miles of conduit were required to wire controls of the new two-stand, four-high temper mill at the new No. 2 Tin Mill of the Youngstown Sheet & Tube Co. Shown before the concrete floor was poured, the conduit will contain wires which serve the main motor-generator set consisting of a 3500 hp drive motor, six generators totaling 5160 kw, and the mill proper which will be driven by motors providing 6400 hp.

Cross Fertilization Needed If Progress To Continue

APPLICATION of automation to both military and commercial needs in this country is being jeopardized and curtailed through the duplication of scientific efforts and the failure of technical communications, according to **Thomas Roy Jones,** president of Daystrom Inc. These beliefs were expressed before Rep. **Wright Patman's** Subcommittee investigating automation. This subcommittee on economic stabilization reviewed developments in the general area of automation and technological changes which have occurred since the extended congressional hearings into automation held last year.

Jones proposed a basic system of communication, fostered by a joint military-civilian organization, by which accumulated scientific knowledge and experience in the instrumentation - automation field could be made available on a broad basis.

"With the urgency of needs in these areas, it is criminal for people to spend time rediscovering truths already known — to go through all the growing and applications pains which have previously been gone through by someone else," Jones said.

Jones also told the committee that potential use of automation is being hamstrung by the inadequate supply of technically trained personnel at all levels and proposed that a portion of the time young men spend in military service be devoted to training in physics, chemistry and mathematics.

MANUFACTURING INDUSTRIES must spend at least \$1½ billion a year to buy new equipment for the 400,000 or more new workers who join the country's production force each year—and spend another \$3 billion to help the total labor force achieve greater production rates and quality at lower cost according to **James C. Kelley,** general manager, American Machine Tool Distributor's Association. Investment in new machine tools is now near one-fifth of that annual rate.

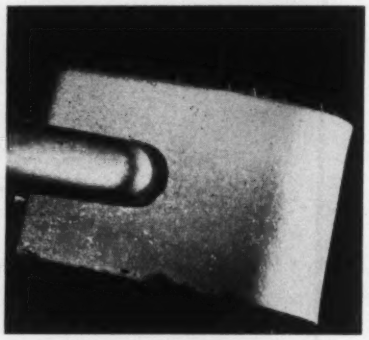
Lithographers Accept It

JOINT labor and management automation forum on lithographic technical progress was held in New York. According to *Industrial Relations News,* approximately 3500 labor union members and employers attended the meeting. Addressing the forum, **Edward Swayduck,** president, Local 1, Amalgamated Lithographers of America, stated, "Our union accepts automation. We don't fear progress, we welcome it. If through education of union members, new short cuts and processes can be learned which will bring the product to the customers faster and at less cost, then this is the way to build a bigger industry."

Hotter Electrical Equipment

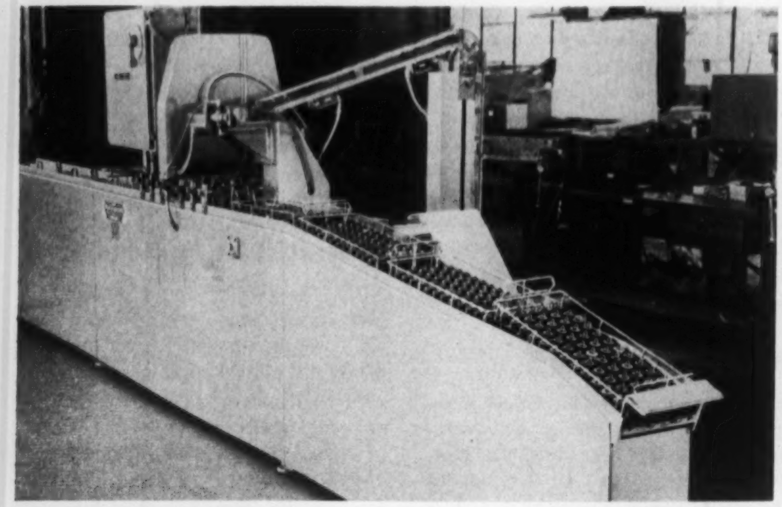
INCREASED life and efficiency plus reduced size are forecast for electrical equipment because of a newly developed clad copper wire which will allow operation at higher temperatures for longer periods of time than are now practical. In a new metallurgical technique announced by Westinghouse Electric Corp., the wire is encased in a thin protective coating of aluminum and a second coating of high-temperature insulation enamel. Effectiveness of the construction is due to the isolation of the copper wire from attack by oxygen in the air. No insulation completely seals wire from air, so copper oxide forms at high temperatures on the surface of common copper wire. This layer gradually grows in depth causing the insulation to degrade and lowering the ability of the wire to carry current, thereby increasing the heat produced in carrying a given current.

Problem in developing a successful aluminum-clad wire was to get proper adhesion while preserving ductility: The two metals tend to react metallurgically with each other to form a brittle layer between them. To overcome this difficulty a copper rod is plated with silver, which acts as a barrier to the interaction of aluminum and copper. The silver-plated copper rod is then inserted into a thin-walled aluminum tube and the assembly is rolled into a smaller diameter rod. This rod is drawn through dies to form wire of the desired size and shape and the wire is then coated with insulation. In finished wire form the silver plating is about 0.0005-inch thick and the aluminum skin about 0.0025-inch thick.



RESEARCH has disclosed that hairlike metallic strands—called "whiskers"—grow on some metals. The illustration shows an enlarged view of ½ by 1½-inch sample of 1/32-inch thick ordinary cold rolled steel, electroplated with tin, which has been kept in a glass jar at room temperature for about three years. Bell Telephone Laboratories is particularly interested in the phenomenon since whiskers could cause short circuits between closely spaced metal surfaces. Telephone scientists now take into consideration the whisker-growing potentialities of various metals as new equipment is designed.

IN A MOVE to diversify in a confident and expanding metalworking market, the R. K. LeBlond Machine Tool Co. has purchased the Fosdick Machine Tool Co. Fosdick employs about 200 people and manufactures drilling, grinding and precision jig boring equipment which will complement the LeBlond line of lathes. The two firms will continue to do business independently.



LOADING of parts into baskets can be accomplished automatically by equipment developed by the Gear-O-Motion Div., Michigan Tool Co. Illustrated machine can basket up to 3000 small pinions per hour. Parts are fed by an enclosed chain lift to a curved channeled fixture. The baskets contain rows of prongs which are indexed under the fixture, a row at a time. If desired, double or triple dwell time of indexing can be provided, enabling the stacking of more than one object on each prong in the basket.

ALL SHARES of Detroit Power Screwdriver Co., manufacturer of power-driven screwdrivers and related automated assembly equipment, were acquired by Link-Belt Co. The Detroit company has 95 employees and will be operated as a subsidiary under its present management.

Coffee Brewed To Order By Automatic Vender

VACUUM-PACKED cans of coffee are used for on-the-spot brewing in a new coffee vender being marketed by the Vendo Co. The 900-cup self-brew machine uses a new method, called infusion brewing, to make coffee from quarter-pound cans of regular grind coffee. The cans themselves serve as disposable brewing chambers within the machine. When the machine is activated, a can is automatically punctured at both ends and jets of hot water are forced through under pressure. The coffee itself acts as a filter, and the grounds remain in the can for easy disposal. The vender holds 54 cans, each of which produces about 16 cups of coffee. Used cans and the grounds they contain drop into a waste receptacle. Unit is claimed to make good coffee available around the clock and to be the cleanest coffee vender on the market. Sales of several thousand units are expected, with the majority going into industrial production areas.

SYSTEM capable of digitally recording pressure, temperature, flow, speed and other parameters from a number of engine test cells simultaneously will be installed at the Willgoos Gas Turbine Laboratory, Pratt & Whitney Div. of United Aircraft Corp. Records will be automatically typed on digital log sheets and also punched on tabulating cards. Raw data will thus be immediately available for insertion into a digital computer for test analysis. Shortly after a single pushbutton is depressed, the component under test may be set up for the next test point while the data recording system completes production of the logged record and the punched cards. Equipment is to be furnished by Fischer & Porter Co. and will record pressures

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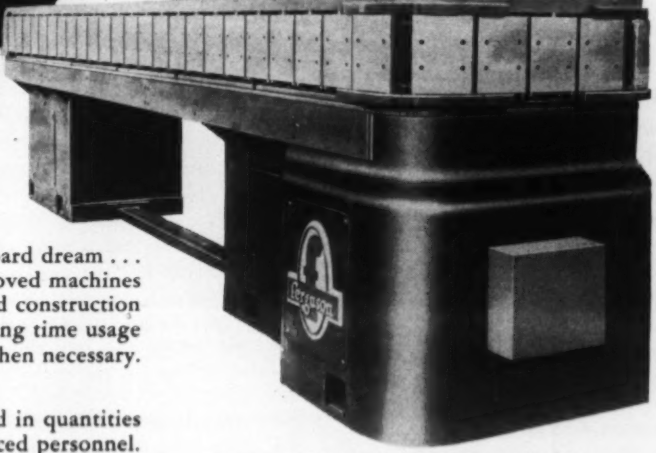

BECAUSE:

① They are more than a drawing board dream . . . the Ferguson bases are real and proved machines with the versatility, rigid construction and low maintenance that permit long time usage and re-tooling when necessary.

② Ferguson machines are produced in quantities and assembled by experienced personnel. They cost less than a special base of comparable quality.

③ Ferguson machines are standard. Parts can be interchanged or replaced. Costly design time is reduced and delivery time is shortened. No "de-bugging" is required.

④ There is a wide range of standard Ferguson bases. One will meet your requirements with little or no compromise with optimum working conditions.

⑤ Ferguson bases give you smoothness of operation and accuracy of parts location because they include the famous Ferguson Drive, acknowledged to be the ultimate in high speed, precision indexing mechanisms.

⑥ Our competent engineering staff, including field engineers in principal cities, can give you genuine assistance in selecting the proper base for your application.

If automatic assembly is on your mind — for either now or in the future — it will pay you to get the facts from Ferguson. Write for our literature or ask for an engineer to call. There is no obligation.

CATALOG 301

Complete data on Ferguson Index Tables and Rotary Transfer Machines; 26 pages of information; lists tables available from stock for immediate shipment.

BULLETIN 401

Describes the Ferguson Trans-o-Mator, standard multiple station in-line transfer machine for automatic assembly.

TOOLING DESIGN SERVICE

Our Hicks Development Division can design and build a complete automatic assembly machine for you, using our standard bases. Bulletin No. 500 shows many such installations. Write for a copy.

FERGUSON MACHINE CORPORATION OF INDIANA

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through use of their multiple pressure measuring system which reads all pneumatic signals with a single transducer and converts them directly to digital form. Contract is said to be the largest single undertaking of its kind in the aircraft manufacturing industry to date and to represent the largest single order ever received by Fischer & Porter.

THE NEW YEAR, 1957, should find scientific instrument makers holding on to a 10-40 per cent sales increase scored during 1956 according to **Kenneth Andersen,** executive vice president, Scientific Apparatus Makers Association. Prediction is based on the country's continued surge toward more research and development, and more automatic processing.

Bendix Acquires Sheffield In Stock Exchange

DIRECTORS of the Bendix Aviation Corp. and the Sheffield Corp., major developers and manufacturers of precision gaging and measurement instruments and industrial inspection and quality control systems, have approved a combination of the two companies.

It is announced that Sheffield will continue to operate under its present management as an intact unit, retaining its corporate title as a wholly-owned subsidiary. Sheffield's present management will continue to conduct the organization's business, and the corporation will retain product brand names long standard in all types of industrial precision gaging and measurement controls.

FORMATION of a new Boston Div. to be composed of two sections, Instruments Section (formerly Doelcam Div.) and Semiconductor Products Section (formerly Transistor Div.) has been announced by Minneapolis-Honeywell Regulator Co. **George J. Swartz,** divisional vice president and general manager, will have responsibility for all phases of the new division's operations. Offices will be at 1400 Soldiers Field Road, Boston. Davies Laboratories Inc., Beltsville, Md., manufacturer of specialized high-speed data recording systems, has been purchased by Honeywell and will be part of their Industrial Div. Operations will continue at Beltsville under **Gomer L. Davies.**

Ultrasonic Equipment Use Due For Major Expansion

AMERICAN users, led by the Air Force, Navy and Atomic Energy Commission, are expected to buy more ultrasonic equipment in 1957 than in all previous years. This prediction was issued following an ultrasonics symposium organized by Acoustica Associates Inc. and Mullard Ltd. Purpose of the meeting was to describe the co-operative plans of the two firms to speed ultrasonic developments in industry. In this respect, Acoustica Associates Inc. has been appointed national distributor of Mullard ultrasonic devices, including an ultrasonic drill and a low-cost ultrasonic soldering iron both presently made in England.

Some of the present applications are: Cleaning and degreasing of metals; testing for flaws in metals; measuring thickness of metal parts from one surface; cleaning of various glass containers; measurement and control of viscosity of liquids; degassing of liquids; sterilization at low temperature; testing for imperfect bonding in laminations and plated metals; and cold flow joining of thin metal strips.

TRADE NAME, know-how, and other assets of Metrotype Corp., Michigan City, Ind., were acquired by Bailey Meter Co. Systems for data measurement and presentation through analog-digital conversion, telemetering, and data logging will continue to be engineered and manufactured in Michigan City for the present. Eventual complete integration with the Bailey organization in Cleveland is planned.

ACQUISITION has been announced by Ex-Cell-O Corp. of two firms: Cadillac Gage Co., Roseville, Mich., producer of plug and ring gages, special height gages, servo-valve mechanisms and fire control mechanisms for army tanks; and the Smith Bearing Co., Trenton, N. J., maker of anti-friction needle bearings. Both firms became wholly-owned subsidiaries of Ex-Cell-O and will operate as separate units under their existing managements.

MOVING into expanded plant and office facilities at 135 Reynolds Rd., Mentor, O., is Automation Development Corp.

Streaming Potential At Work

PRESSURE PICKUPS introduced by Consolidated Electrodynamics Corp. are based on the electrokinetic effect known as the "streaming-potential" phenomenon. The device will measure dynamic pressures, which may consist of complex waves from sonic vibrations, blast pressures and hammer in liquid-filled lines. Pressure applied to the diaphragm of a sealed, liquid-filled cell causes a small amount of polar liquid to flow through a porous disk, generating an electrical signal. The new pickup is said to operate in a pressure range from 0.0001 to 100 psig and a temperature range from --10F to 140F with a flat response between 3 and 25,000 cps. Pressure oscillations in this frequency bracket produce electrical signals that are in phase with and proportional in amplitude to the pressure.

High Frequency Current Is Versatile Package Inspector

INSPECTING a large variety of packages for uniformity or to insure that contents are as intended is a common industrial problem. Methods in use today include weighing machines, metal detectors, height sensors, etc. The Photobell Sales Corp., New York, has introduced a new inspecting device based on the use of high frequency current passing through the entire package. Materials respond to this current in proportion to their own electrical properties, as well as to the volume of materials present. High frequency current will usually permeate right through the package itself, measuring the quantity of most materials

Askania Regulator Company NEWS

Automatic Controls for

FLOW, PRESSURE, RATIO, COMBUSTION, EDGE POSITION AND THICKNESS

ELECTROJET® PROVIDES ½ H.P. TO 40 H.P. HYDRAULIC OUTPUT FROM LOW LEVEL ELECTRICAL INPUT

FROM TRANSDUCERS:

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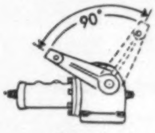
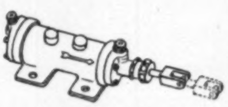
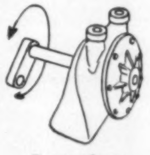


Crank Moment



Linear Motion



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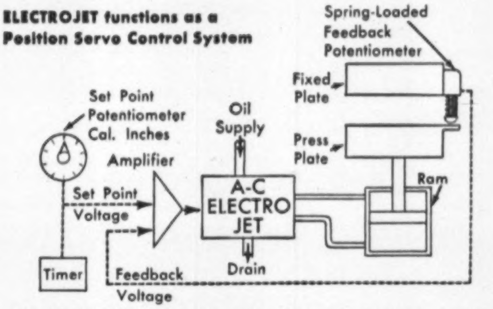
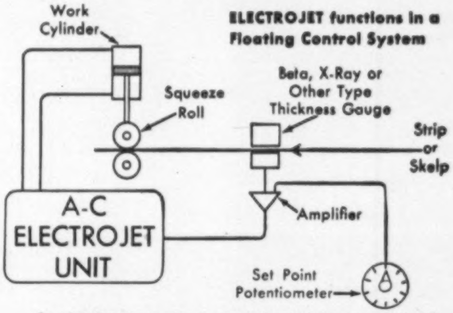

Spring-Loaded Feedback Potentiometer
Fixed Plate
Set Point Potentiometer Cal. Inches
Oil Supply
Press Plate
Amplifier
Ram
Set Point Voltage
A-C ELECTRO JET
Timer
Feedback Voltage
Drain

In this instance to control the thickness of the sheet felt being produced on an hydraulic press.

ELECTROJET functions in a Floating Control System


Work Cylinder
Squeeze Roll
Beta, X-Ray or Other Type Thickness Gauge
Strip or Skelp
A-C ELECTROJET UNIT
Amplifier
Set Point Potentiometer

In this instance to control the thickness of steel strip in a Rolling Mill

STUDY THESE SPECIFICATIONS

A-C ELECTROJET

Reference winding (constant)	115v, 0.15 amp, 50-60 cps
Control winding (variable)	0-115v, 0-0.15 amp
Break-loose voltage	2v max.
Jet Pipe pressure	110-150 psi std, 400 psi max.
Jet Pipe flow (examples)	1.2 mm nozzles; 100 psi, 0.6 gpm 2.5 mm nozzle; 400 psi, 5.2 gpm
Booster pressure	2000 psi max.

D-C ELECTROJET

Maximum power input	6 watts
Coil resistance	5 ohms to 20,000 ohms
Break-loose power	20 microwatts
Hydraulic specifications	As for A-C Electrojet

Amplifiers for both A-C and D-C Electrojets are available to meet almost all requirements. However, in most applications the D-C Electrojet requires no amplifier.

Send for application bulletin No. 38.1

THE ASKANIA REGULATOR COMPANY APPLICATION BULLETIN NO. 38.1 contains
16 diagrams and illustrations to describe
1 available ELECTROJET types
2 applications and operation factors
3 types of Final Control elements, etc.
You'll want this bulletin for application... for study....for ready reference.

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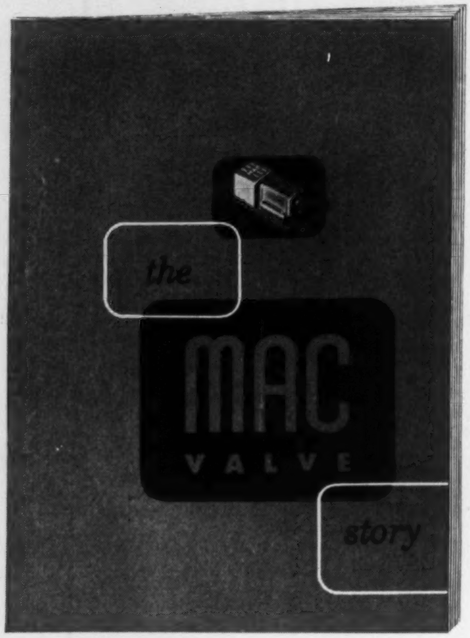
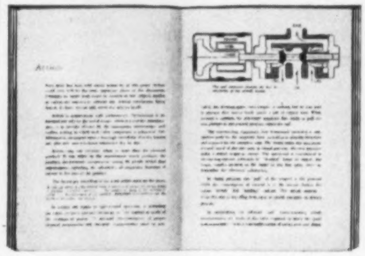
FACTS



THE "MAC" VALVE STORY . . .
Basic principles

Basic Principles



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. . . about air valves!

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MECHANICAL AIR CONTROLS, INC.
DETROIT 37, MICHIGAN
MAC

by allowing current to flow in proportion to the amount of material present. Since some materials conduct electrical current more efficiently than others, it is also possible to single out certain materials inside a complicated package, and determine if they are present in the wanted quantity, ignoring other materials in the package.

Types of products that can profitably be checked in some manner with this equipment are: Crackers, spices, breakfast cereal, bottled liquids in a carton, inserted extras, tubes in cartons, polyethylene bagged items and most cartoned items.

EXPANDED EFFORTS in research, engineering and manufacturing of hydraulic, mechanical, electromechanical and electronic devices are envisaged for Eastern Aircraft Products Corp., organized by the Weatherhead Co. to acquire the assets of Eastern Aircraft Products Corp. and Eastern Precision Parts Co. Inc., Orange, N. J. Operations will continue at Orange with the present managements and personnel.

ACQUISTION of Dynamics Research Associates, a Seattle engineering group, by Universal Match Corp. has been announced. The Seattle firm will operate as a division of Universal Match. Dynamics Research is engaged in manufacture of a line of magnetic amplifiers. In research and development, the company has been concerned with automatic controls for food and chemical processing, plant and machine automation, and automatic laboratory and airborne instrumentation.

CONTRACTS calling for the design and construction of a machine that will automatically sort, feed and assemble the parts of an electrical relay have been awarded by International Business Machines Corp. to Multra Corp., a subsidiary of Barnes Engineering Co. The relay to be assembled consists of nine parts: a frame, two springs, an armature, a coil, an adjusting plate, and three screws. These relays are standard parts in IBM electric accounting machines and computers.

AUTOMATION'S DEVELOPMENT in pharmaceutical companies is creating a need for more highly-trained technicians than ever before says **E. L. Baab,** corporate training manager, Olin Mathieson Chemical Corp. He told the 50th

PRODUCTION methods for new type Charactron Shaped-Beam Tube give no indication of the amazing performance of the device. The new type tube, now being produced by Stromberg-Carlson, Div. of General Dynamics Corp., can reproduce 1,200,000 letters and numbers per minute for photographic recording. Numbers and letters are formed on a phosphor-coated screen as a result of electron beam being projected through a tiny metal stencil within the tube. The diameter of the tube is 7 inches; characters can be reproduced 10,000 to a frame in 100 lines of 100 characters each. The rate of display is 20,000 characters per second.

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THE HYDRAULIC PRESS MFG. CO.
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annual mid-year meeting of the American Pharmaceutical Manufacturers' Association that this is true from an economic standpoint because today's competitive markets demand that manufacturers be as effective as possible in the use of employees since large portions of their budgets are consumed as payrolls. He feels a committee of supervisors from production, service groups and maintenance can keep a training program practical and steer it for maximum effectiveness in the plant.

INTERESTS of the Armzen Co. in the Sendzimir Cold Rolling Mill have been acquired by Waterbury Farrel Foundry & Machine Co. These Armzen interests will be incorporated into Waterbury Farrel's operating structure as a new division, the Sendzimir Mill Div., with **T. Sendzimir** as manager and staffed by present Armzen personnel. Previously, Waterbury Farrel was the principal manufacturer of Sendzimir mills under license from the Armzen Co. which handled sales, engineering and servicing.

STRETCH To Shorten Design Time

DEVELOPMENT of a general-purpose super-computer, STRETCH, has been ordered by the U.S. Atomic Energy Commission for installation at Los Alamos Scientific Laboratory. General performance specifications outlined in the contract with International Business Machines Corp. would make the unit between 100 and 200 times faster than any comparable general-purpose calculator available today, and would permit it to solve problems of much greater scope and complexity. Need for the unit is based on the trend toward reactors and other apparatus so complicated that 100 billion arithmetical operations could be required to make a single evaluation. Such a problem would require six months to work out on a present-day computer running 20 hours a day. The object of Project STRETCH is to produce a machine which could answer the same problem in about one day. Multiplications of 12 to 15 digit numbers at more than 500,000 per second and addi-

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405	435	465	495	525	555	585	615	645
406	436	466	496	526	556	586	616	646
407	437	467	497	527	557	587	617	647
408	438	468	498	528	558	588	618	648
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423	453	483	513	543	573	603	633	663
424	454	484	514	544	574	604	634	664
425	455	485	515	545	575	605	635	665
426	456	486	516	546	576	606	636	666
427	457	487	517	547	577	607	637	667
428	458	488	518	548	578	608	638	668
429	459	489	519	549	579	609	639	669
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425	455	485	515	545	575	605	635	665
426	456	486	516	546	576	606	636	666
427	457	487	517	547	577	607	637	667
428	458	488	518	548	578	608	638	668
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Information Service

For your convenience, advertisements and items of information on new equipment, components and manufacturers literature now can be quickly identified by an *Item Number* printed just below each unit.

For additional free information circle item number on an inquiry card. Fill in your name, title, address, etc.—Drop it in the mail—No Postage Required—Your request will receive prompt attention and will be filled directly by the manufacturer.

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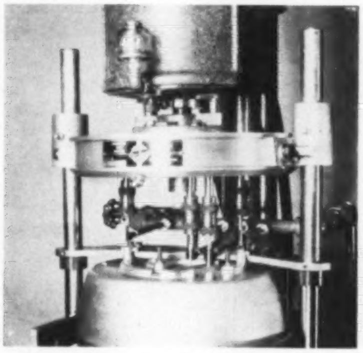
tions at about 2 million a second are planned. An interesting point about the development will be the use of other automatic computers to design parts for this automatic computer.



NEED for a reversing motor on this Ettco-Emrick lead screw tapping unit has been eliminated by use of Warner Electric Brake & Clutch Co. fractional horsepower forward and reverse clutches. The complete lead screw unit is a self-contained, electrically controlled and actuated device which can be used for fast single or multiple spindle tapping or threading. In operation, when the tool has reached the depth to which it is set, a nut actuates a snap-acting switch, the magnetic downfeed clutch is de-energized, the reverse clutch is energized, and lead screw and tap reverse and run out of the work. Torque output of the clutches can be varied by a rheostat control to provide the sensitivity needed for small taps as well as the power required to drive large taps.

Improved Line Supervision With Better Communications

SUPERVISORY personnel recognize an acute need within management ranks for better communication, both of information and attitudes, according to a study conducted by the National Management Association.

When asked to rank six things that might be done to improve the supervisor's job, the special survey sample listed in order of importance the following: More and quicker information from top management on policies and decisions; better understanding of just what is expected of the supervisor; more participation by the supervisor in management decisions; more training; more authority; and more pay.

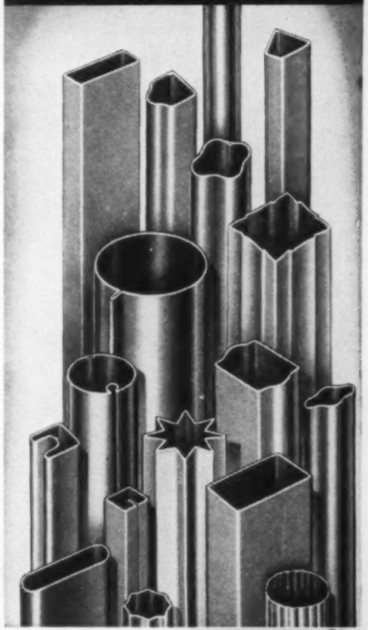
A special question of the survey dealt with automation. The respondents were asked, "What effect do you think automation will have on management-labor relations?" Only 6 per cent answered there would be very few problems. Forty-two per cent said there would be "some new problems requiring special attention." Fifty-two per cent thought there would be "many new problems requiring careful management consideration."

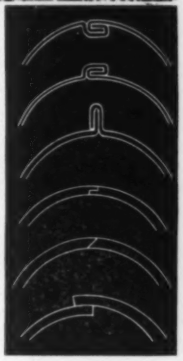
Group Solicits Suggestions In Study of Feedback Components

INCREASING emphasis in the field of feedback control systems is being placed on the systems aspect of the problem through analytical and computer studies. This has meant that with the system design somewhat removed from the design or detailed operation of the specific components involved, it is important that the methods for defining, describing, specifying, and testing system components receive proper attention. A subcommittee of the Feedback Control Systems Committee of the AIEE is seeking to build specifications of various feedback control system components. The subcommittee is soliciting comments and suggestions for making their work more effective to system designers and component manufacturers.

To aid in developing the specifications, the subcommittee has been subdivided into small groups which are working on specific components as follows: Synchros — **L. F. Kazda**, Dept. of Electrical Engineering, University of Michigan; **M. Goldberg**, Naval Dept., BuOrd Code RES4D, Washington; Gyros—**P. Spink**, Westinghouse Electric Corp., Friendship International Airport, Baltimore; **Robert Keeler**, Minneapolis-Honeywell Regulator Co., Minneapolis; Two-phase servomotors — **T. A. Westover**, Servo Corp. of America, New Hyde Park, N. Y.; **W. D. Jefferson**, John Oster Mfg. Co., Racine, Wis.; DC motors —**R. G. Beadle**, General Electric Co., Systems Application Engineering, Schenectady; **L. F. Stringer**, Westinghouse Electric Corp., Metal Working Section, Pittsburgh; Transformers and magnetic amplifiers—**D. D. Pidhayny, H. C. Trueblood**, Ramo-Wooldridge, Los Angeles; Potentiometers and pick-offs — **C. W. Miller**, Perkin-Elmer Corp., Norwalk Conn.; **J. A.**

COLD ROLL FORMING TUBULAR SHAPES





Among the wide variety of things you can make on a Yoder Cold Roll Forming machine are round, square, oval, rectangular and other tubular shapes, such as illustrated. The seams may be open, lapped, butted, dovetailed, interlocking, etc.—as shown in the drawing.

Millions of feet of such unwelded tubular shapes are made from coiled strip for conductor pipe, bedsteads, lamp stands, window channel, wiring raceways, carrying rods, etc. Production ranges from 20,000 to 50,000 feet per day, with only one operator and a helper.

Yoder offers you the cooperation of their engineering staff for designing and adapting their cold roll forming machines, auxiliaries, and tooling, for the low cost production of structurals, mouldings and trim, panels, tubular and other shapes, to meet individual needs.

The Yoder Book on Cold Roll Forming is a complete, illustrated text on the art and the equipment needed for performing a variety of operations which can be combined with cold roll forming, at little or no extra labor cost. A copy is yours for the asking.

THE YODER COMPANY
5526 Walworth Ave. Cleveland 2, Ohio

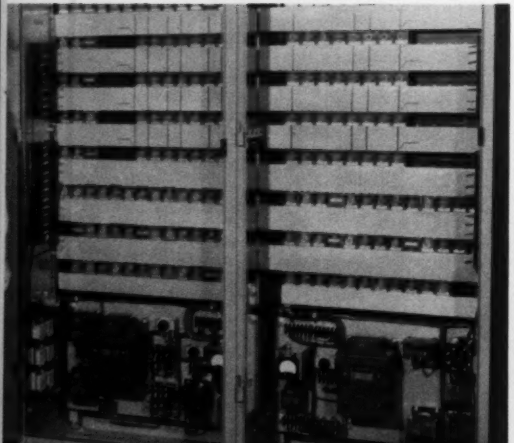
YODER ENGINEERING MANUFACTURING
COLD-ROLL FORMING MACHINES

Circle 563 on Inquiry Card

Next Page Circle 564→

VOLTAGE STABILIZING TRANSFORMERS

Here's how G-E voltage you increase production



On this newly developed General Electric static switching system control panel, General Electric voltage stabilizing transformers are used to help prevent malfunctions due to large voltage variations.

In Ford Motor Company's new Mahwah, New Jersey assembly plant, G-E voltage stabilizing transformers are used to stabilize control current on the more than 11 miles of assembly lines. More than 60 G-E voltage stabilizing transformers installed primarily on control centers at the Mahwah Plant hold relays in during line surges caused by electrical storms.

stabilizing transformers can help in your manufacturing processes

If your manufacturing processes require control of speed, color, position, thickness or uniformity—you need General Electric voltage stabilizing transformers. Your ability to compete in the marketplace depends upon your meeting the increasing demands of appearance, design, uniformity and quality, and at the same time, increasing production without increasing costs or losses due to poor quality control or test standards.

If your process utilizes beta-ray thickness gages, electronic counters, X-ray inspection or other electronic measuring instruments, the results will only be as effective as the stability of the input voltage. Incorrect voltage means erratic speed control. Result: poor quality, rejects.

In all process industries, such as textiles, wallpaper, aluminum foil, floor covering, printing—precise voltage is a key to increased production.

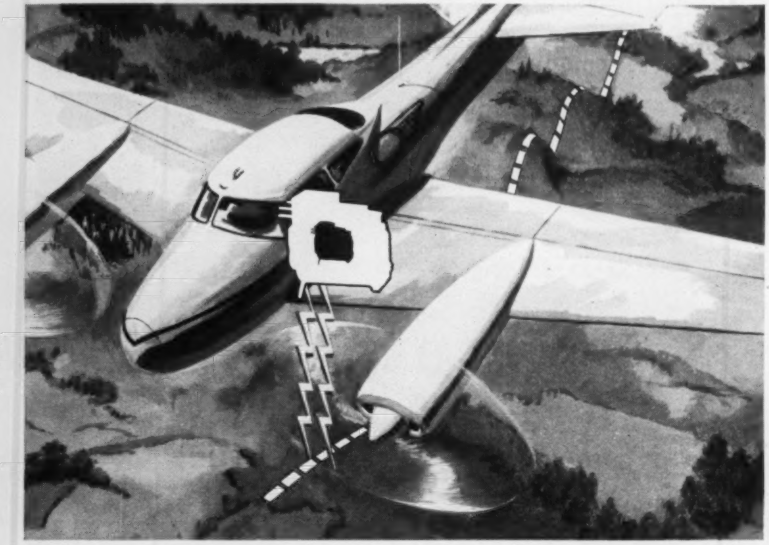
General Electric voltage stabilizing transformers are extremely sensitive and have a high speed response. In addition, they are completely automatic, lightweight, inexpensive and rugged.

Another benefit you get with G-E voltage stabilizing transformers is *continuous* production. Due to the sensitivity and high speed response, voltage will remain at a level high enough to keep control relays locked in even when line voltage is reduced by as much as 75% of rated line voltage—your production line will continue to operate.

For further information, and to learn how General Electric voltage stabilizing transformers can increase *your* production, contact your nearest G-E Apparatus Sales Office, or write for bulletin GEA-5754 to Section 410-49, General Electric Company, Schenectady 5, New York.

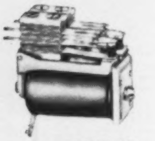
GENERAL ELECTRIC

Potter & Brumfield *engineering is in this picture*

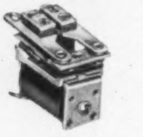


Which P&B relay did Television Associates specify

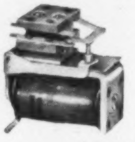
FOR THEIR AIRBORNE COMPUTER?



MH Series



MB Series



MC Series

Surveys for pipe lines, electric transmission routes and microwave paths are now made from the air, by radar. Television Associates of Indiana, Inc. developed this speedy new technique—and the equipment—which provides clients with detailed profiles of the terrain to be crossed.

Part of the equipment, an intricate airborne computer, requires relays that are fast-acting, light weight, versatile. They must have high shock and vibration resistance and remain operative in temperatures ranging from −45°C to +85°C.

Modified MH relays by P&B were specified. These miniature relays meet all Television Associates' requirements and provide high reliability in a mighty small package. Challenging relay problems are solved daily at P&B. Twenty-five years of creative engineering are behind every P&B relay. Write today for our new catalog.

ENGINEERING DATA

SERIES: MH Miniature Telephone.

CONTACTS: Up to 18 springs, maximum 9 in each stack, forms A, B, C, D, E, X and Y. AC relays are limited to a maximum of 2 poles. Various contact material available.

VOLTAGE RANGE: DC - .05 to 110 V.—AC - 6 to 230 V. 60 cycle.

COIL RESISTANCE: 22,000 ohms maximum.

TEMPERATURE RANGE: High temperature range (DC) —55° C. to +135° C. Standard DC —55° C. to +85° C. Standard AC —45° C. to +40° C. Other temperature ranges available to specification.

TERMINALS: Standard pierced solder lug holes will take (2) No. 18 hook-up wires. Adaptable for printed circuits.

ENCLOSURES: Dust cover plus wide range of hermetically sealed covers and types of terminations.

DIMENSIONS: 1-9/16" L. x 25/32" W. x 1-3/8" H. (4c Relay).

P&B RELAYS AVAILABLE AT MORE THAN 500 DISTRIBUTORS IN ALL PRINCIPAL CITIES

Potter & Brumfield, inc.

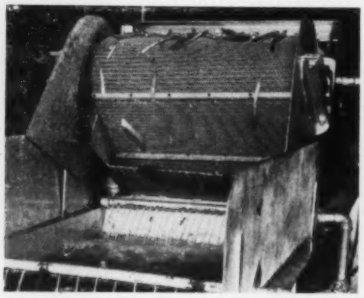
PRINCETON, INDIANA *Subsidiary of* AMERICAN MACHINE & FOUNDRY COMPANY

Manufacturing Divisions also in Franklin, Ky. and Laconia, N. H.

Circle 565 on Inquiry Card

Mitchell, Hughes Aircraft, Culver City, Calif.; Accelerometers, integrators, and precision power supplies—**A. Paternini,** Bell Aircraft, Buffalo; Analog-digital and digital-analog devices—**C. H. Baldwin,** Westinghouse Electric Corp., Youngwood, Pa.; Hydraulics — **Warren Gaines,** General Electric Co., Schenectady; **Andrew A. Seleno,** Vickers Inc., Detroit; **E. S. Sherrad,** Bureau of Standards, Washington, D. C.; **D. C. Morin,** Blackhawk Mfg. Co., Milwaukee.

Comments and suggestions for making the work of the subcommittee more effective will be welcomed and should be directed to the individuals working on the specific components.

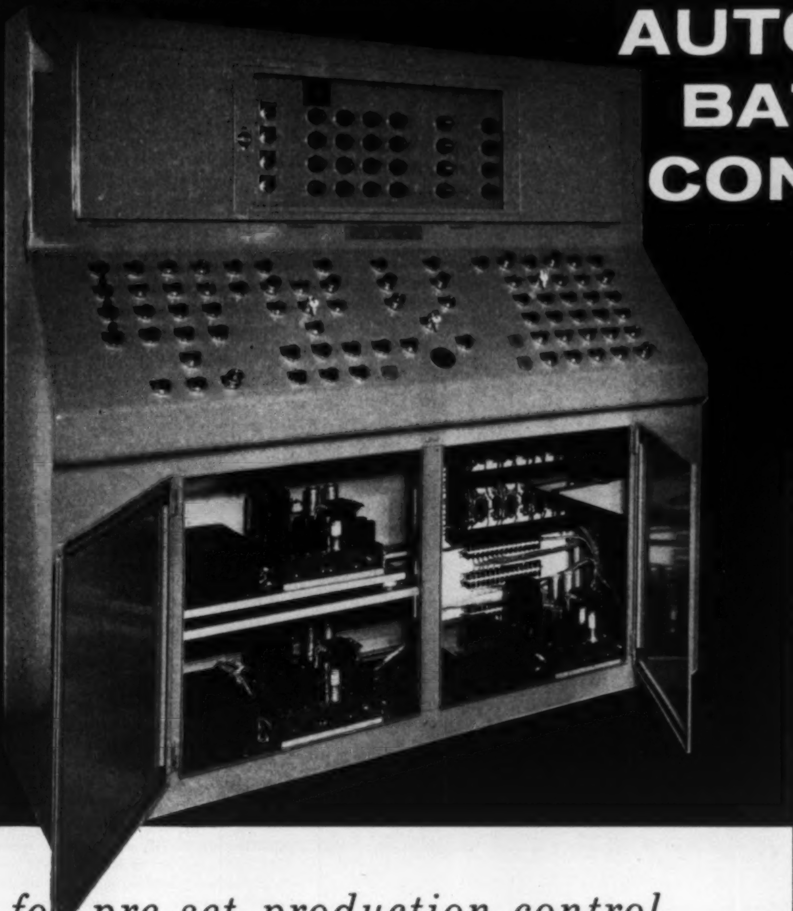


WIRE MESH belts are peculiarly adaptable to continuous processing in food industries. Vegetables must be washed and blanched prior to other operations such as freezing. Illustrated belt is conveying asparagus through washing cycle. Open mesh in belt permits free drainage of process solutions and rapid circulation of steam and cold air. Metal belt is resistant to wet corrosive conditions and extremes of temperature. The belt is a product of the Cambridge Wire Cloth Co.

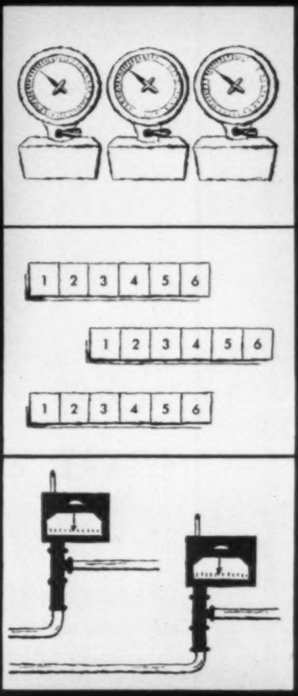
Tests Show Teflon Is Good Lubricant and Preservative

VERSATILITY of Teflon as a dry lubricant and preservative for metals has been demonstrated in Marine Corps test of weapons coated with the material. An interim report of the tests has been released through the Office of Technical Services, U. S. Dept. of Commerce (PB 121286 Teflon, price $1.25).

Teflon is a preparation of the plastic polytetrafluoroethylene. The report tells of its use as a water suspensoid applied by air or electrostatic spray and air dried. For example, automatic rifles and 20 mm projectiles were coated with thin films. The coatings were found to provide suitable protection



AUTOMATIC BATCHING CONTROLS



for pre-set production control

This Gemco custom batching control, one of many for the aggregate and ready-mix concrete industry, typifies the control possible on a variety of batching problems.

It enables pre-setting of four batching formulas, with weight limits accurate to 1 in 5000 and each cycle started by a push-button. Digital registers enable pre-setting for various types of aggregate, for water content, and for cement content. Signal amplifiers for the weight pick-ups can be either conventional or Gemco magnetic amplifiers. Such Gemco techniques offer opportunity also for batch type production of small parts on one or many machines in unison or sequence, in plastics, in food processing — anywhere that intermittent or variable products call for discrete quantities in terms of weight, dimension, volume, count, etc.

GEMCO
CUSTOM CONTROLS

WHAT'S YOUR CONTROL PROBLEM?

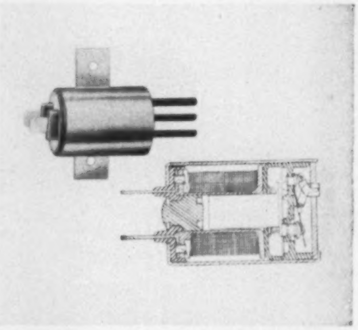
Gemco designs and builds special controls and systems for all industries, including automatic machining, materials handling, parts testing. For specialized control needs, bring your problems to the control specialists.

GEMCO ELECTRIC COMPANY • 25681 W EIGHT MILE RD. • DETROIT 19, MICH.

Circle 566 on Inquiry Card

for weapons in long term storage despite a total lack of care. The films resisted absorption of any liquid, and adherence of ice, dust and dirt. Coated equipment was ready for use as it was removed from packing.

Original coatings of Teflon afforded lubrication for small arms under all circumstances for an almost indefinite period. Neither low nor extremely high temperatures hampered operation of coated weapons. The firing of coated projectiles actually improved the condition of the barrels and cleanliness of firing chambers.



ELECTROMAGNETIC switching device produced by Guardian Electric Mfg. Co. is totally enclosed in metal case with molded bakelite at the contact end to protect against moisture and dirt. Units are available for any voltage from 6 to 115 v ac or dc. Contacts are rated up to 8 amp at 115 v, noninductive. Simplicity of the device permits economical manufacturing, making the unit ideal for control applications in washing machines, dryers, refrigerators, and other major appliances.

Unionized Engineers Studied To Answer Big Question—Why?

ENGINEERING unions now claim as members nearly 60,000 of the nation's 500,000 engineers, according to a study just completed by the National Industrial Conference Board. While these figures show that engineers are far from constituting a unionized segment of the economy, they do indicate possible dissatisfaction among engineers.

To determine why unionism has occurred among a group considered by many as unorganizable, the Board questioned executives of companies whose engineers were unionized, officials of engineering unions, engineering societies, and engineers themselves. Findings showed that many engineers are

If it's hard to hold...

call Garrison

The harder the holding problem . . . the better we like it!

We specialize in custom-made holding fixtures.

We designed and built the first automated gear chucks in the world . . . all are still in use . . . reorders have been many . . . millions of gears have been made on these automation chucks.

Call us the moment the matter of automation arises, because the part to be processed must be located properly before the machine can do the work.

To automate or not to automate — that is the question

If you are in Standardation* and not ready for the plunge into automation . . . we can design special holding fixtures for your standard machines that will help match the efficiency and production capacities of automated equipment!

If you are already in automation (the process is not new to us) . . . we are prepared to build special holding fixtures for your automated equipment.

Interested?

**Our own word for Standard Practices.*

GARRISON MACHINE WORKS, INC.

DAYTON 4, OHIO, U.S.A.

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BLISS HIGH PRODUCTION PRESSES "do-it-themselves" at Black and Decker

Just three Bliss High Production Presses produce the millions of motor laminations Black and Decker uses in its complete line of more than 150 portable power tools!

Running in the upper speed range, sometimes at well above 250 strokes per minute, through two shifts a day—and occasionally three. And they've been doing it for a long time now with no problems.

Of course, H-P presses are built for speed. Extra heavy cast Meehanite frame • *Square* gibbing • Automatic lubrication • Variable speed drive • Special air friction clutch • Counterbalanced crankshaft. Every feature has been especially designed to maintain precision at top speeds. That adds up to top production rates, longer die life.

Another plus, users tell us, is the wide open die area that makes quick set-up and changeover possible. In fact, the fast set-up makes *short-run* work practical with Bliss H-P Presses. And the room *under* the press is a handy place to run chutes or store tote boxes.

If production of short-stroke stamped parts is your problem, long run or short, you'll want to learn more about Bliss H-P presses. Our recently revised 32-page catalog No. 27-C describes the entire line and gives examples of the wide range of work you can accomplish with these presses. Why not write for a copy today.

BLISS
SINCE 1857

is more than a name... it's a guarantee

U. S. Plants **in Canton, Cleveland, Salem and Toledo, Ohio; Detroit and Hastings, Michigan; Midland and Pittsburgh, Pa.; San Jose, California;** ***Branch Offices*** **in Boston, Burbank, Chicago, Cleveland, Dayton, Detroit, Indianapolis, New Haven, New York, Philadelphia, Rochester, San Jose, Salem, Toledo, Washington, D. C.; and Toronto, Ontario, Canada; E. W. Bliss (England) Ltd., Derby; E. W. Bliss Co. (Paris), France.** ***Other representatives throughout the world.***

E. W. BLISS COMPANY, CANTON, OHIO • Presses, Rolling Mills, Rolls, Special Machinery

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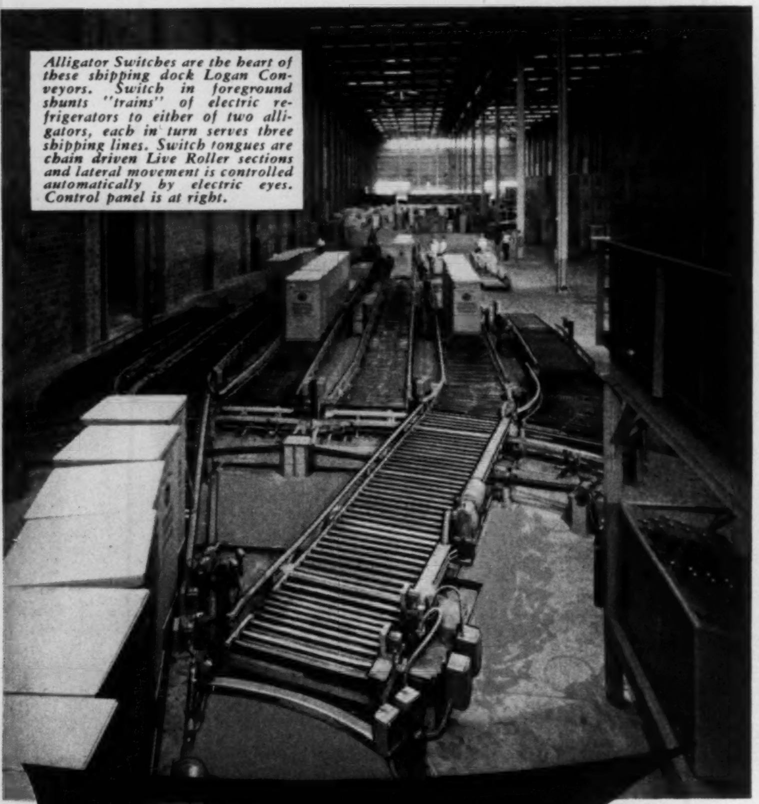
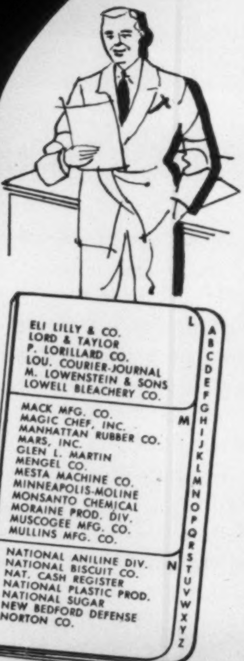


Alligator Switches are the heart of these shipping dock Logan Conveyors. Switch in foreground shunts "trains" of electric refrigerators to either of two alligators, each in turn serves three shipping lines. Switch tongues are chain driven Live Roller sections and lateral movement is controlled automatically by electric eyes. Control panel is at right.

The
LEADERS
use *Logan*


ELI LILLY & CO.
LORD & TAYLOR
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N
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Leadership, in the industrial world, is closely allied to the use of mass production equipment such as Logan Conveyors. Large plant or small, the "principles" of mass production can be utilized to advantage. Conserving manpower, saving priceless time, increasing plant capacity, maintaining satisfactory working conditions are some of the contributions which Logan Conveyors make to the mass production process. Let Logan work for you, too. Write for nearest engineer or for further information.

LOGAN CO., 218 CABEL ST., LOUISVILLE 6, KY.

Logan Conveyors

not completely happy with their financial position, their status as professionals, and their treatment as individuals.

The answer to discontent, say union leaders, is unionism. But engineering societies, who believe unionism is incompatible with the engineer's professional status, point out that employers have the power to improve employment standards for engineers. In a recent discussion of this subject, **Dr. Herbert R. Northrup,** vice president, Penn-Texas Corp., said that management can accomplish the job for the employee-engineer which must be done today by treating engineers: "(1) as members of the management organization. . . through such items as fair compensation, practical recognition of professional personnel as part of management and appropriate methods to bring the grievances of professional employees to the attention of top management, and (2) as members of a profession. . . by including time and facilities for research, study, reading, publishing, and otherwise maintaining professional status, and by placing emphasis not on day-to-day output but on ideas contributed to the long-run worth of the business."

One of the chief financial complaints of engineers is that the earnings differential between salaried engineers and wage earners has become too narrow in many companies. And in terms of fringe benefits, engineers say their former advantage over the production worker has been virtually wiped out. Second major financial complaint is that existing salaries for engineers have not kept pace with increases in the hiring salaries of engineers.

Union leaders say that engineers unionized to regain the professional status they felt they lost with mass employment. Engineering societies likewise report genuine professional dissatisfaction. But they maintain it stems from the fact that many companies do not fulfill the engineer's desire to be classified as part of the management team.

As professionals, the Conference Board study points out, engineers want: (1) better communication with management in order to clarify their understanding of company policies; (2) credit in reports and

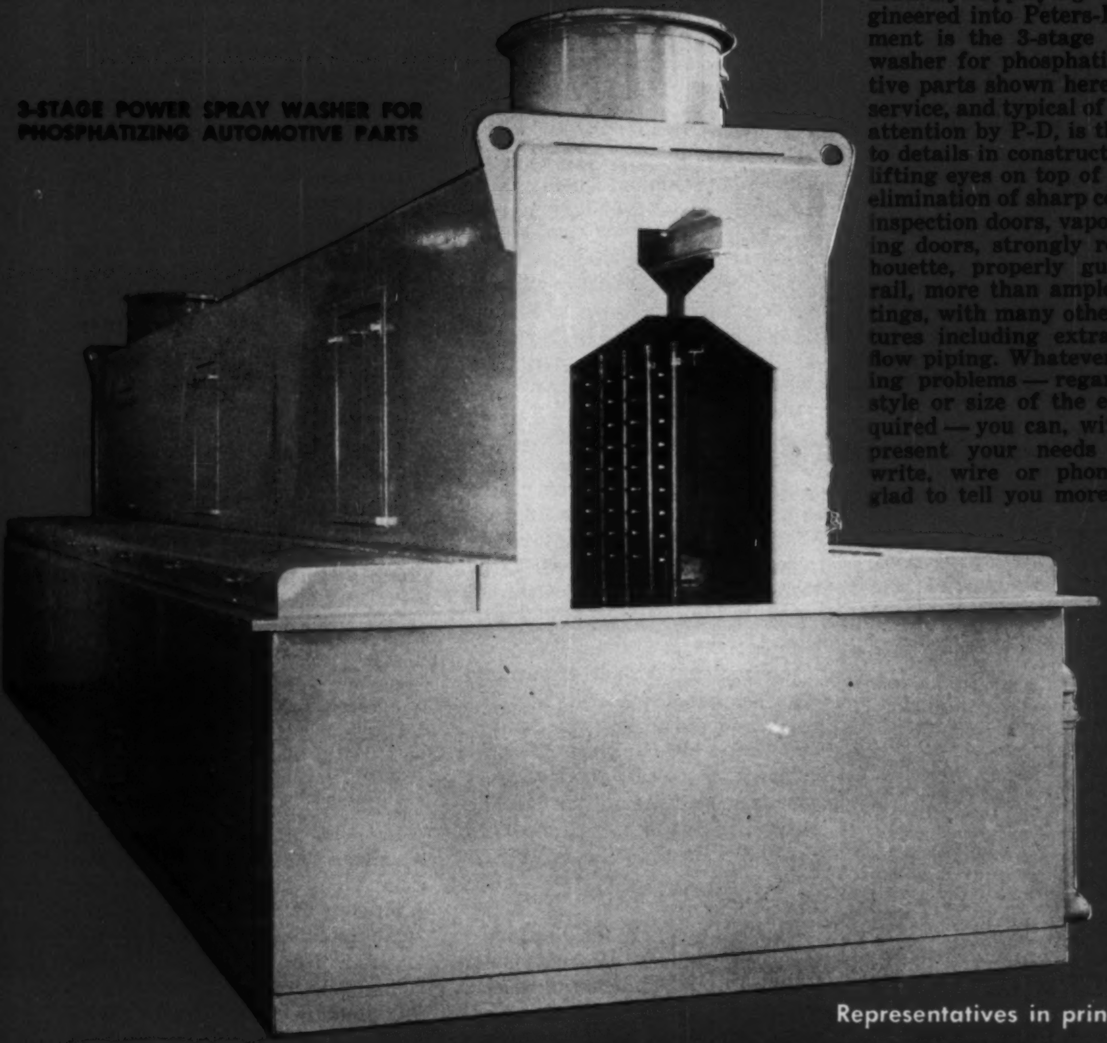
Built to Span the Years—

POWER SPRAY WASHERS

by PETERS-DALTON

Quality of construction is most important to consider when selecting equipment, particularly that used for high production runs. Efficient operation and dependable service can be had only when this equipment is manufactured to endure, and is correctly installed.

For more than a quarter century Peters-Dalton has been designing, engineering and building power spray washers, paint finishing systems, baking and drying ovens, air make-up systems, and dust collection systems. They have consistently met the needs and production requirements of industry. Typifying the details engineered into Peters-Dalton equipment is the 3-stage power spray washer for phosphatizing automotive parts shown here. A standard service, and typical of the thorough attention by P-D, is the care given to details in construction. Note the lifting eyes on top of the machine, elimination of sharp corners, ample inspection doors, vapor type charging doors, strongly reinforced silhouette, properly guarded monorail, more than ample exhaust fittings, with many other special features including extra large overflow piping. Whatever your finishing problems — regardless of the style or size of the equipment required — you can, with assurance, present your needs to us. Just write, wire or phone — we'll be glad to tell you more.



3-STAGE POWER SPRAY WASHER FOR PHOSPHATIZING AUTOMOTIVE PARTS

Representatives in principal cities.

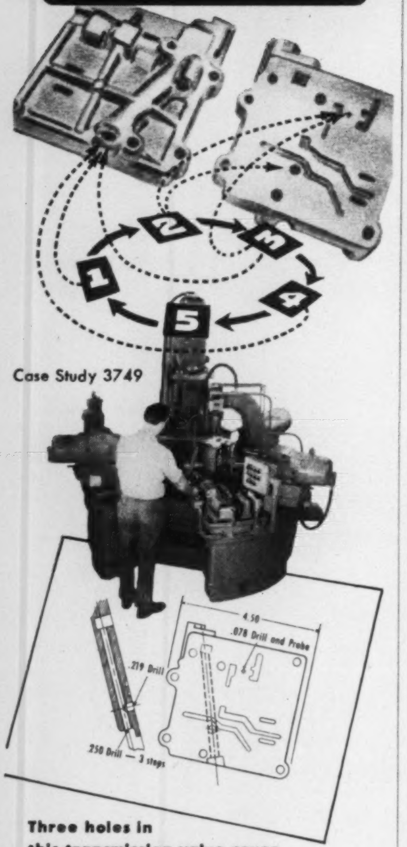
- Hydro-Whirl Paint Spray Booths
- Industrial Washing Equipment
- Drying and Baking Ovens
- Hydro-Whirl Dust Collecting Systems

PD

Peters-Dalton INC.
A SUBSIDIARY OF DETROIT HARVESTER CO.
17894 Ryan Road • Detroit 12, Michigan

drilled and probed automatically in one chucking on a

KINGSBURY



Case Study 3749

Three holes in this transmission valve cover . . . 5 operations . . . 350 parts per hour gross

The machine drills three holes in this aluminum die casting. The customer asked us to probe the tiny .078 hole as the best means of inspection. An air-actuated mechanical probe operates at the next station after this drilling. If the hole is not drilled, the probe trips a limit switch which stops the machine.

We pioneered in these indexing automatics and we still think we can build them better than anyone else. They will produce to your specifications. If you have critical high production drilling and tapping jobs, we'd like a chance to show you what we can do. Kingsbury Machine Tool Corporation, Keene, N. H.

KINGSBURY
INDEXING AUTOMATICS
for high production drilling and tapping

Circle 571 on Inquiry Card

papers they help develop; (3) classification as professionals rather than grouping with nonprofessionals; and (4) less frequent assignments to jobs requiring little engineering ability.

The disappearance of the personal relationship which once existed between engineer and employer is largely responsible for the dissatisfaction engineers now feel as individuals. The engineer objects to being treated on a mass basis in hiring, training, and other employment situations. He feels he has no measure of his progress such as is furnished by job titles, and no way to make his complaints known and to secure redress. In addition, he believes that he is not given sufficient training or job rotation so that he can go through the steps necessary for promotion.

MEETINGS AND EVENTS

Feb. 19—

Rochester Society for Quality Control. 13th Annual Quality Control Clinic to be held War Memorial, Rochester, N. Y. Additional information may be obtained from T. J. Soebbing, Eastman Kodak Co., Navy Ordnance Div., 50 Main St. W., Rochester 14, N. Y.

Feb. 26-28—

Western Joint Computer Conference. Jointly sponsored by IRE, AIEE and ACM, conference theme is "Techniques for Reliability." To be held Hotel Statler, Los Angeles. Additional information may be obtained from S. D. Wanlass, 13729 Victory Blvd., Van Nuys, Calif.

Mar. 11-15—

International Atomic Exposition. With Nuclear Engineering and Science Congress to be held Convention Hall, Philadelphia. Additional information may be obtained from American Institute of Chemical Engineers, 25 W. 45th St., New York 36, N. Y.

Mar. 18-21—

The Society of the Plastics Industry Inc. National conference and Pacific Coast Exposition to be held Shrine Exposition Hall, Los Angeles. Additional information may be obtained from society headquarters, 250 Park Ave., New York 17, N. Y.

Mar. 18-21—

Institute of Radio Engineers. National Convention and exposition to be held Hotel Waldorf-Astoria and N. Y. Coliseum, New York City. Additional information may be obtained from society headquarters, One E. 79th St., New York, N. Y.

Mar. 25-29—

Western Metal Show. To be held Pan-Pacific Auditorium, Los Angeles. Additional information may be obtained from American Society for Metals, 7301 Euclid Ave., Cleveland 3, O.

Apr. 8-10—

American Society of Mechanical Engineers. Spring meeting to be held Dinkler-Tutwiler, Birmingham. Additional information may be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

Apr. 9-11—

American Welding Society. National spring meeting and exposition with technical sessions cosponsored with AIEE to be held Hotel Sheraton and Convention Hall, Philadelphia. Additional information may be obtained from R. T. Kenworthy, 12 E. 41st St., New York 17, N. Y.

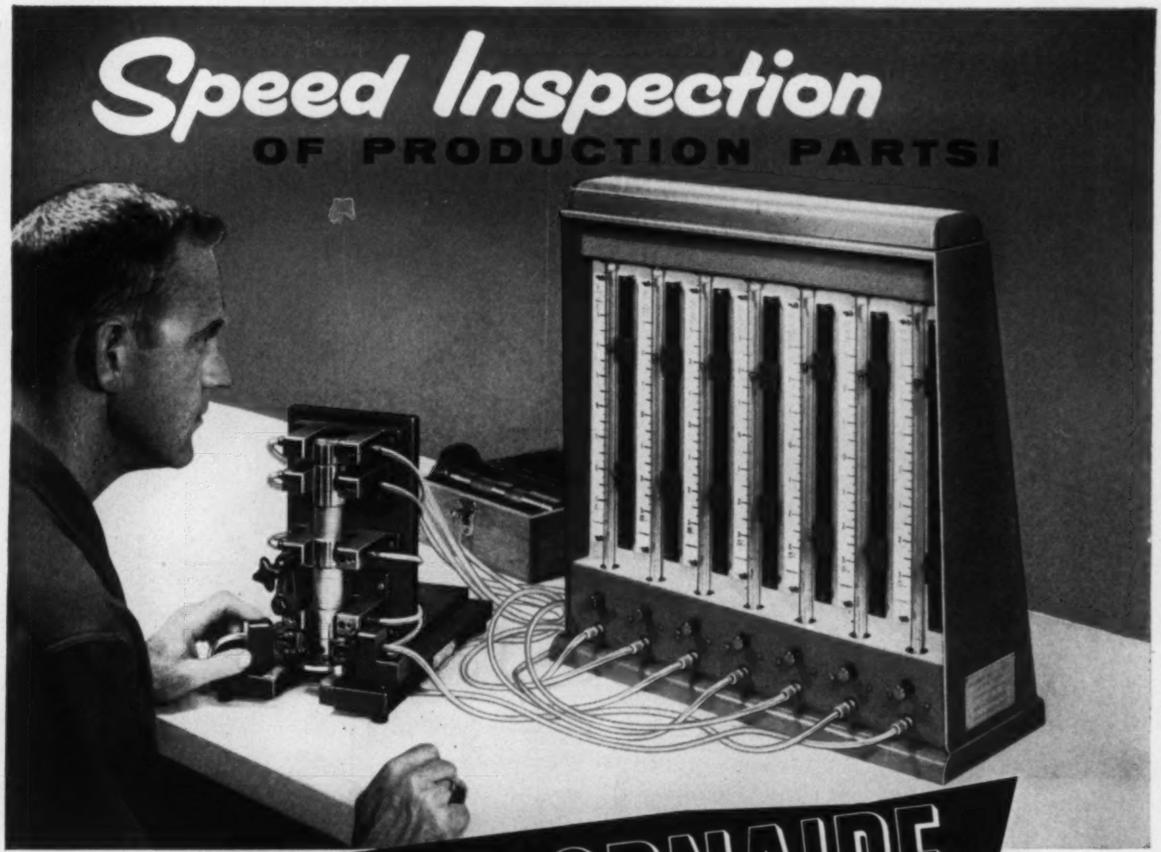
Apr. 15-17—

Symposium on Systems for Information Retrieval. Demonstrations of working systems and symposium on problems and techniques—co-sponsored by School of Library Science of Western Reserve University and the Council on Documentation Research, to be held on the campus, Cleveland. Additional information may be obtained from J. H. Shera, School of Library Science, Western Reserve University, Cleveland 6, O.

Apr. 29-May 3—

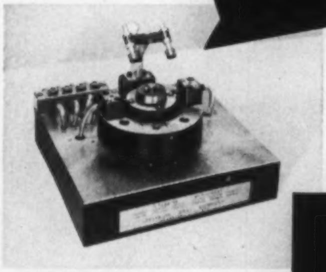
Materials Handling Exposition. American Material Handling Society will hold conference in conjunction with show having theme "Materials Handling, Key To Automation." To be held Convention Hall, Philadelphia. Additional information may be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Speed Inspection
OF PRODUCTION PARTS!



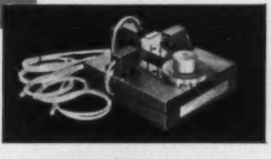
NEW DEARBORNAIRE

MULTIPLE COLUMN AIR GAGING INSTRUMENTS



Special Air Gaging Fixtures designed and built to meet your particular application requirements. Complete engineering service available upon request.

Send part print showing all dimensions to be checked and tolerances required for prompt quotation and delivery.



To speed inspection of production parts, new Dearbornaire air gaging instruments are now offered in multiple column units designed to permit more accurate simultaneous checking of as many dimensions as may be required for a given part. What's more, each unit incorporates all of the advanced design features which have made Dearbornaire the most practical, most versatile column type instrument ever produced . . .

- New higher rated pressure system and built-in circuit restrictions make them virtually self-cleaning, reduce maintenance to a minimum.
- New glass tube has a characterized internal taper which provides positive linear accuracy over the full extent of the calibrated scales.
- Easy-to-read Zero-centered scales permit use of instrument for normal inspection, statistical quality control, and as a tool setting gage.
- Interchangeability of component parts simplifies conversion from one amplification to another, reduces spare parts inventory costs.

Plus a complete line of air gage spindles, rings, snaps and cartridges all precision finished to give you greater accuracy, longer wear life. Free demonstration arranged upon request. Write for details today!

AIR GAGE DIVISION
DEARBORN GAGE COMPANY
22038 Beech Street • Dearborn, Michigan

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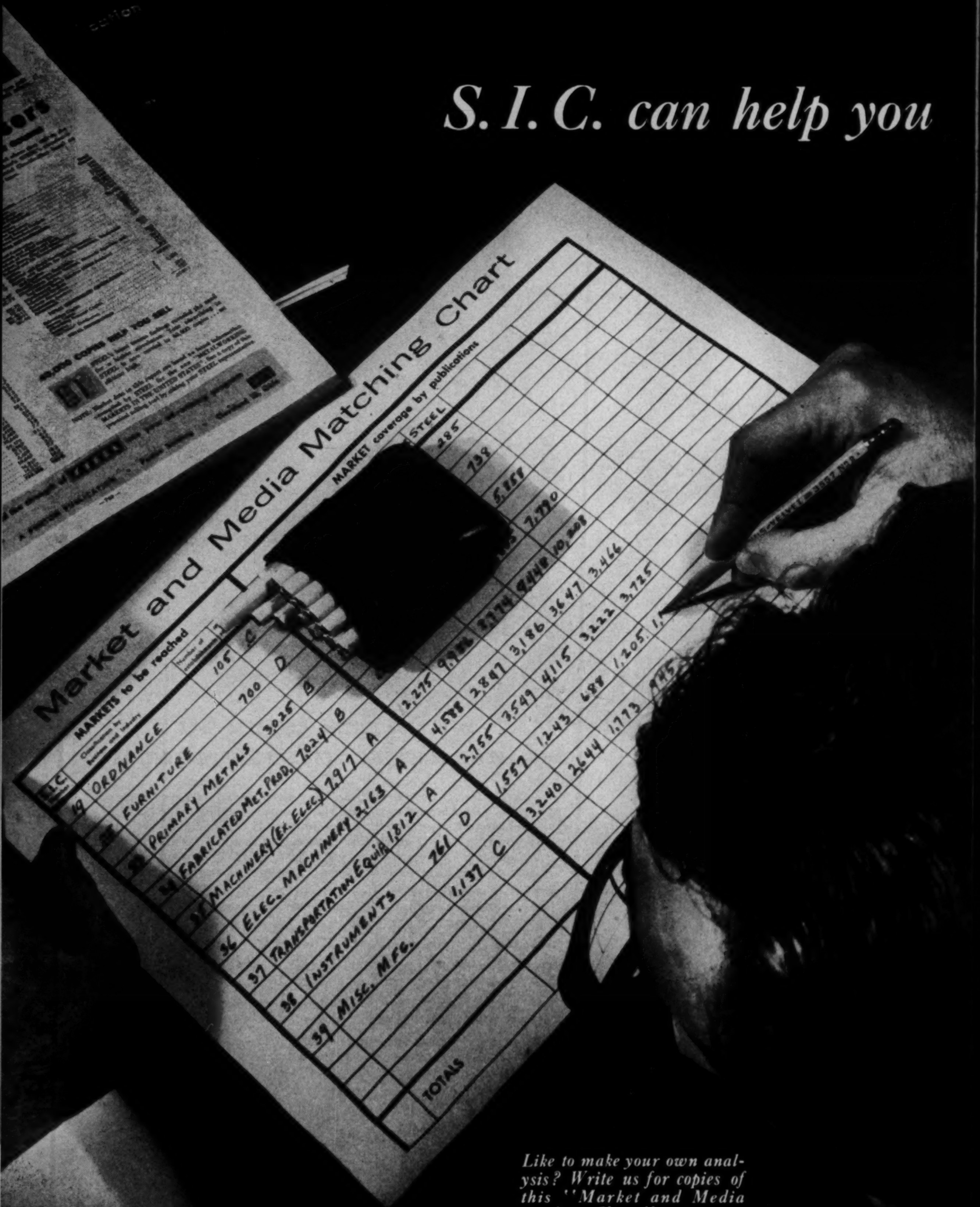
S.I.C. can help you


Market and Media Matching Chart
MARKETS to be reached
MARKET coverage by publications
STEEL
S.I.C.
19 ORDNANCE 105 C
25 FURNITURE 700 D
33 PRIMARY METALS 3025 B
34 FABRICATED MET. PROD. 7024 B
35 MACHINERY (EX. ELEC.) 7917 A
36 ELEC. MACHINERY 2163 A
37 TRANSPORTATION EQUIP. 1812 A
38 INSTRUMENTS 761 D
39 MISC. MFG. 1,137 C
285
138
5,858
7,790
10,208
9,448
8,774
9,986
2,275
3,466
3,647
3,186
2,847
4,588
3,725
3,222
4,115
3,549
2,755
1,205
688
1,243
1,557
945
1,773
2,644
3,240
TOTALS

Like to make your own analysis? Write us for copies of this "Market and Media Analysis Chart."

to match media to markets

How often, in buying business paper space, have you wished for some method of matching circulation to your market?

. . . Or a simplified, fast way of finding out what proportion of the worthwhile establishments and buying power you were reaching with a publication?

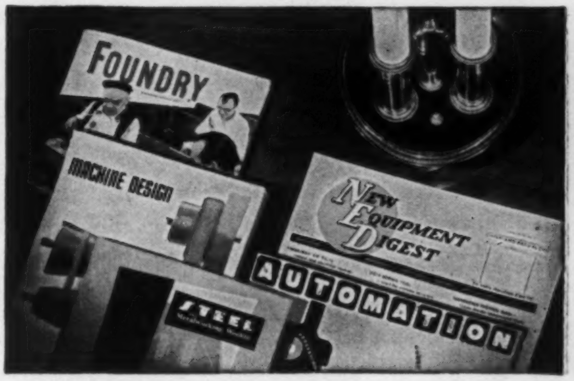
One advertiser calls it, "Taking the hocus-pocus out of circulation".

You can do it with S.I.C.—combined with the Penton Census. Reporting on the Standard Industrial Classification basis is distinctly a PENTON development—and a vital part of the Census Operation.

Take STEEL Magazine, for instance. When you look at the circulation analysis, you'll see how we've already matched circulation to the market for you. To help you quickly find out how we stack up, you can run your eye down the plant counts, and compare the coverage figures for every product category. You can readily see what proportion of the worthwhile establishments you're reaching.

You'll find similar information available on each Penton publication, to aid you in Media Selection.

This method of matching media to the market is made possible through the use of S.I.C. and the Penton Census. It's just one of the advantages of doing business with Penton.



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Publishing Company

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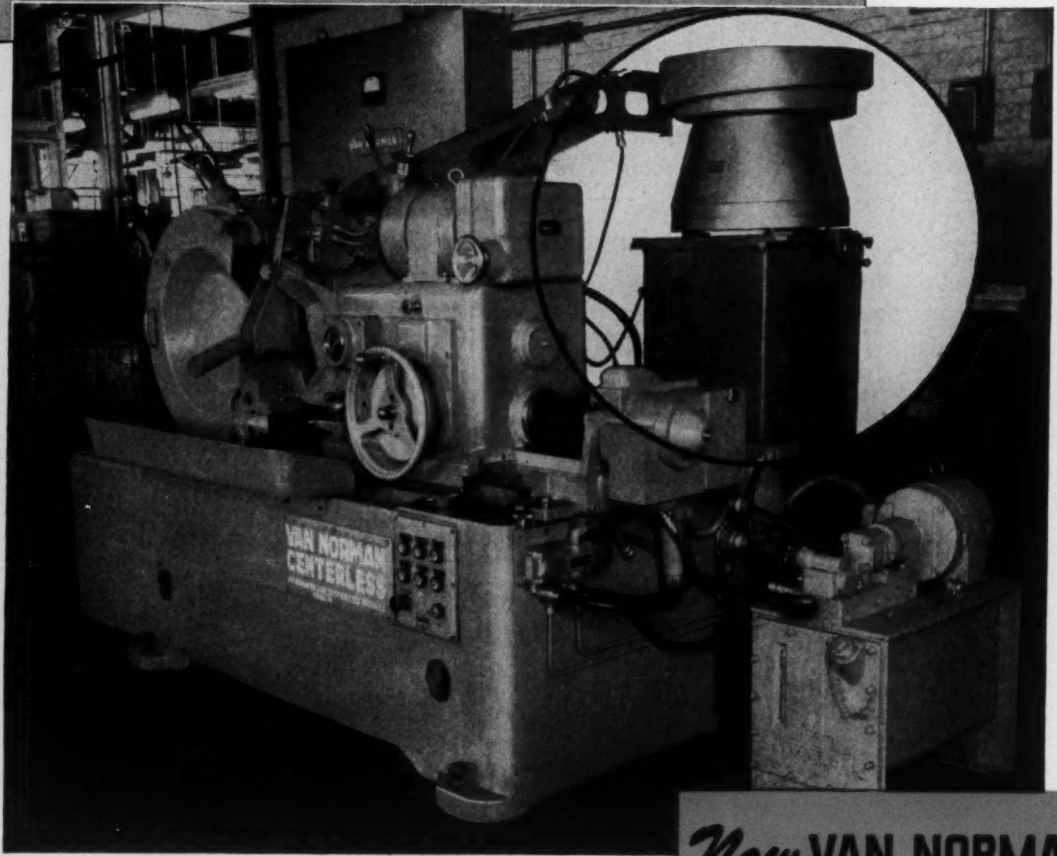
PRODUCTION EQUIPMENT
produces MORE with Peeco



Now **VAN NORMAN MACHINE COMPANY production equipment includes DEVELOPED Peeco FEEDERS**

As a leader in the field of vibratory parts feeders PEECO is contributing its share towards the greater capacities being achieved by new production equipment. We are glad to include, among the companies in this field now being served by PEECO, the Van Norman Machine Co. of Springfield, Massachusetts.

If you want to produce more, send for bulletin #356 and ask for the name of the PEECO representative in your area.

PEECO works with original equipment manufacturers to help engineer greater capacities into new production equipment. This Van Norman Centerless illustrates a single PEECO feeder (Model 25) installed with orientation track.

THE WORLD'S LARGEST EXCLUSIVE MANUFACTURER OF VIBRATORY PARTS FEEDERS

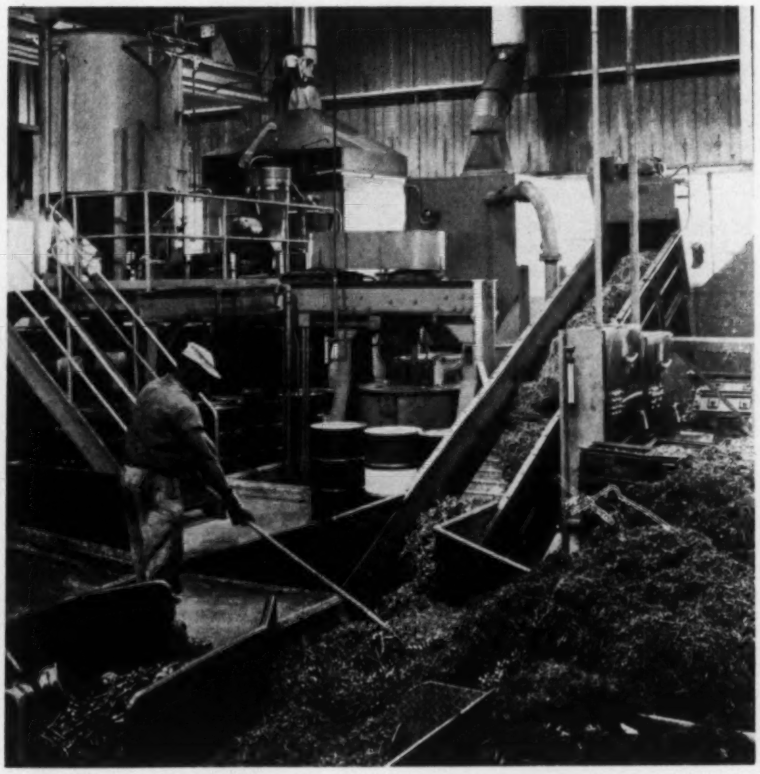
Peeco **PERRY EQUIPMENT & ENGINEERING CO.**

ERIE, PA. • • • DIVISION OF AUTOMATION DEVICES, INC.

Circle 574 on Inquiry Card

detroit dateline

By **JAMES C. KEEBLER**
Associate Editor



Operator rakes chips onto conveyor which carries them into reclaiming unit at Thompson Products' Valve Plant. In the left background is a section of the equipment that cleans and sterilizes the oil that is removed from the chips.

Automated Chip Handling

WHEN the Bull of the Woods would ask that obstreperous lathehand Sam Snarl, "What are you making," the answer was always, "Chips." Metalworking has a history steeped in chips.

Chip Prestige

Many a fastidious Grandma insisted that Gramp leave his working shoes at the shop so that the chips ground into his shoeleather didn't grind up her livingroom rug.

When the early machine tool builders decided to associate, and needed a parameter by which one could separate this breed from the poor benighted machinery builders they chose to glorify the humble chip by stating that if the machine made chips it was a machine tool. The dictionary still clings to this distinction even though the National Machine Tool Builders' Association now takes in pressmakers and defines the field as: (a) A metal-cutting machine tool is a power-driven machine, not portable by hand, used for the purpose of removing metal in the form of chips. (b) A metal-forming machine tool is a power-driven machine, not portable by hand, used to press, forge, emboss, hammer, blank or shear metal. (NOTE: This definition is not intended to include die casting machines, extruding machines, powdered metal presses, rolling mills or welding equipment.)

Goodbye Mr. . . .

The trend today seems to be away from strict concern with making chips. Machine tool builders are selling handling devices, gaging equipment, spinning, bending and heat treating machines, and even molding equipment. This is production machinery without chips.

Automation is playing a leading role in establishing this trend toward switched emphasis. Manufacturing engineers are spending more time in search of how to make the product more economically. This takes the form of studying the overall manufacturing sequence, rather than emphasis on a study of how to remove metal faster on the third operation.

Scorekeepers of the automotive game have been quick to note that: Increased use of close-tolerance, shell-molded crankshafts; upturn in stamped parts and welded drive assemblies over former use of castings; adoption of roll - formed shapes where formerly bar stock shafts were specified; and use of more extrusions and more discastings; have caused a reduction in the amount of chips that need be cut. Clearly the emphasis is on making parts, not on making chips.

However, as in so many other phases of this big wide wonderful subject of automation, a closer look at the facts reveals that there's no need to panic. As elsewhere, the clue here is higher total production quantities. Although the automation engineer of today is not generally pestered with chips in his hair—they do still give him headaches.

Great Piles

Where chips are being cut on automated equipment the rate of stock removal and the total quantity of the production runs not only presents the automaker with great quantities of machined parts but also makes him the happy pappy of great piles of chips.

One supplier of automotive

Guarantee TOP Performance and Maximum Life!

Specify THESE TOP QUALITY FEATURES...

(Standard on Miller Cylinders at no extra cost)

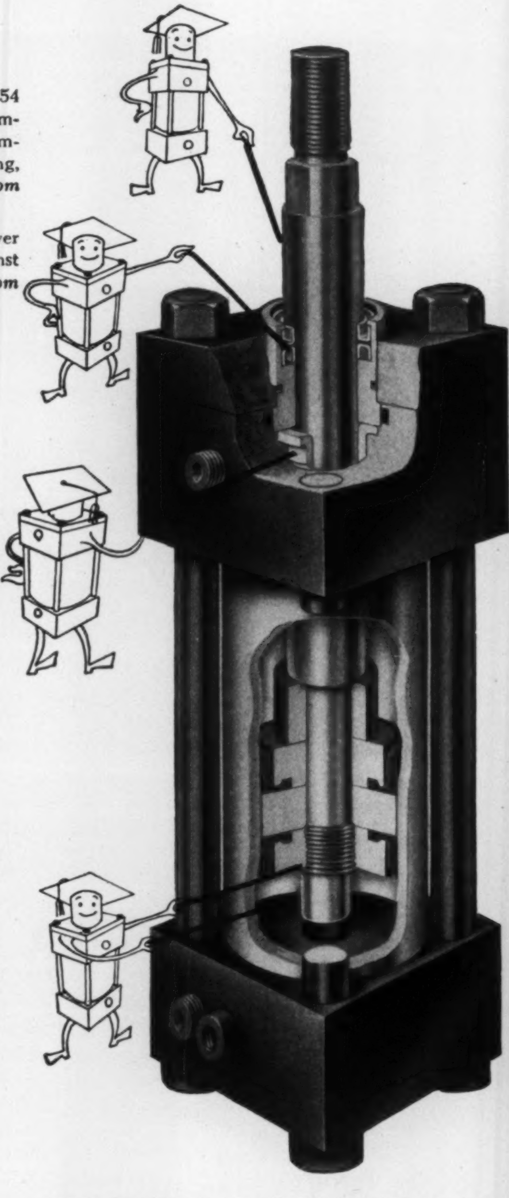
Specify CASE HARDENED CHROME PLATED PISTON RODS

On all Air and Hydraulic Cylinders

Benefits To You

CASE-HARDENED Piston Rods (52-54 Rockwell "C") provide practically complete protection against damage from hammer blows, wrench-dropping, mishandling, and similar occurrences. *Available from Miller at no extra cost.*

The HARD CHROME PLATING over the case-hardened rods protects against scratch-damage and rust. *Available from Miller at no extra cost.*



Specify "TEFLON" WIPERS

On all Air and Hydraulic Cylinders

Specify TEFLON HYDRAULIC ROD SEALS

On all Hydraulic Cylinders

Benefits To You

"TEFLON" Rod Wipers and "TEFLON" Hydraulic Piston Rod Seals withstand temperatures from—100°F. to plus 500°F. They are impervious to practically all known chemicals, including the fire-resistant, special, and standard hydraulic fluids in current use. *Available from Miller at no extra cost.*

Specify RUST RESISTANT SURFACES

On all Air and Hydraulic Cylinders

Benefits To You

Highest quality Black Ferric Oxide Finish provides rust protection in air cylinder operation and on all cylinders during shipping and installation.

Cylinder heads, caps, mountings, pistons, followers, tie rods, and the unplated portions of the piston rods have this finish *at no extra cost on all Miller cylinders.* (This finish not recommended for water service)

You may wish to route this entire page to the proper department in your company, by using this handy form. Additional copies on request. →

To (Dept.)________________

"On all our future cylinder requirements, please specify the above quality features."

Signed________________

Title________________

NOTE: On all Miller Hydraulic Piston Seals: Leather Cup Seals are *standard*, Piston Ring Seals are optional at no extra cost and "Teflon" Cup Seals are available at extra cost.

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Circle 575 on Inquiry Card

parts, Thompson Products, piles up about five and one half tons of chips daily at its valve plant. Consideration of this mountain leads to the realization that logistics support of automated machining lines involves more than supplying raw materials, power, coolant and maintenance supervision. Also involved are the problems of taking away the finished product and the by-product—chips.

To make chip disposal an easier and more profitable operation Thompson has installed an automated system which practically eliminates manual handling once the chips have been brought to the processing machine. On the production floor chips are collected in special carts which serve also the function of keeping various materials segregated. Chip carts are taken to a loading platform by fork-lift truck, and chips are dumped in sorted piles.

Here the operator rakes the chips onto a hinged pan-type conveyor which carries them to a crusher where they are broken into small pieces. From the crusher they are conveyed to a centrifuge which removes the oil by whirling them at high speed. Chips leave the centrifuge by way of a pneumatic system that blows them through a tube and into trucks waiting outside.

Before leaving the grounds each truck is driven over a scale which weighs the load. Since the chips are sorted, cleaned, and crushed they bring top scrap price, but this is not the only cost advantage the system offers for the oil removed from the chips is filtered, sterilized at high temperature (to prevent rancidity) and stored in drums for reuse on the line.

Capacity of the system is such that in one eight-hour shift all chips made in the plant in a 24-hour period are processed. Oil reclaim totals 250 drums per month.

Other Systems

In general in the auto industry, chip handling systems vary with the type of material being handled, the layout of the plant, and preferences of the plant engineer. One Ford plant has three systems:

Dry chips—this uses vibratory conveyors from each machine to feed a vibratory floor conveyor which takes the chips to a hopper in a pit. When the hopper is filled an electric light beam is broken, shutting off the oscillating conveyor long enough to allow the automatic elevation of the hopper to empty the chips into a four-wheeled chip-handling cart.

Wet chips—steel turnings are removed by an agitator conveyor that contains a soluble oil which flushes them down rounded-bottom trenches to subfloor tanks. The oil is pumped from these tanks back into the system. Settled chips are removed from the bottom of the tank by inclined conveyors that deliver them to chip-handling carts. Carts used in conjunction with both the dry and wet system are taken to a briquetting house where the automatic cycle includes crushing the chips, pressing them into briquettes, and rolling them on a chute into box cars for delivery to the foundry.

Grindings—these fine chips are flushed down trenches into tanks, the largest of which has a 10,000 gallon capacity.

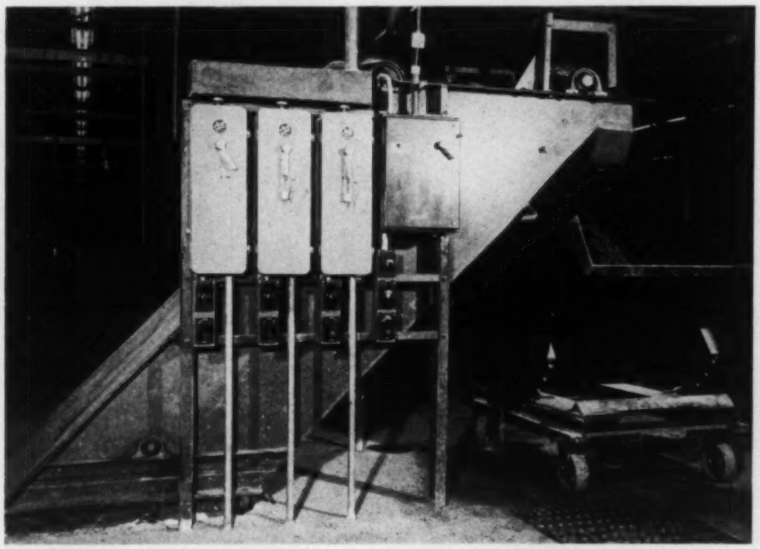
In the Plymouth engine plant all chips, dust and coolant are pulled down through the machines into under-floor trenches. These concrete passageways are the ventilating system that pulls dusty air from the cast iron machining operations; they are fitted with chain flight conveyors to drag chips along the bottoms to a cross-connected conveyor that delivers the chips to a hopper which discharges into a railroad car.

A separate under-floor system takes steel chips and coolant outside for draining and baling. These trenches also have pipelines carrying soluble oil and water to the machines.

Chevrolet has an installation that sucks iron chips and dust into a vacuum system which delivers into a pressurized pneumatic system to blow the chips into a hopper. In this plant a 400 foot-long hinged pan type conveyor in the floor under the automatic screw machines delivers steel chips to hopper carts which are taken to crushing and centrifuge operations.

There's still more than one way to skin the cat—Cleveland Tramrail developed a magnet-carrying system that pulls chips from sump tunnels under the machines and takes a magnet load along an overhead rail to a storage bin area, where the magnet drops the load.

These systems serve to illustrate the magnitude of the chip problem and the complexity of establishing an automated system to service an automated system and maintain efficient low-cost production.



Steel chips from machining operations move along inclined conveyors to chip-handling carts at Ford's Engine Plant No. 1 in Cleveland. The operation is entirely automatic from the machining operation to the point of removal of the chip cart to the briquetting house.

MICRO SWITCH Precision

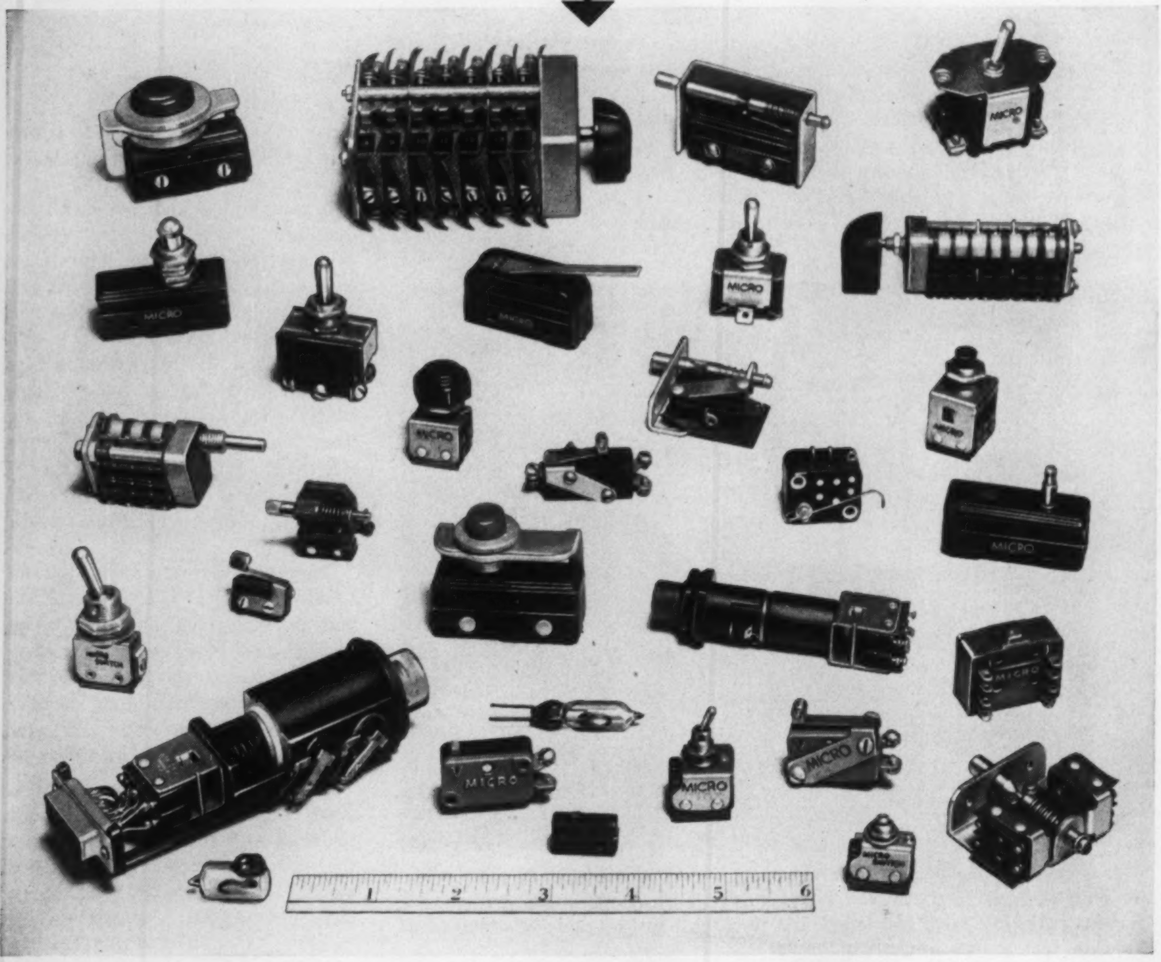
...FIRST IN PRECISION SWITCHING

small . . . accurate . . . reliable . . . precise MICRO SWITCH Precision Switches meet wide range of modern electronic control requirements

Design engineers find MICRO SWITCH precision switches to be ideal components for computers, high speed switching devices and other industrial devices.

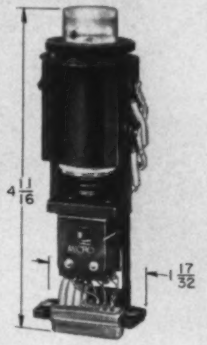
Whether the requirement is for an individual switch—or a complete switch assembly—MICRO SWITCH Engineering is at your service. Development of precise, reliable switching components is our sole business. Our switching specialists have met successfully many knotty problems of switch design and application. This long, practical experience will save YOU time and money.

A call to the nearest MICRO SWITCH branch office will put MICRO SWITCH Field and Factory Engineering to work on your specific problem. This cooperation can be your short cut to improved design.



Switches have uses unlimited

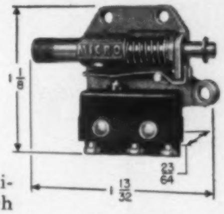
3-LIGHT PUSH BUTTON SWITCH FOR COMPLEX CONTROL PANELS



Here is a new, unique indicating push button switch which lights in three different colors. It is the latest MICRO SWITCH development for use in complex console panels. This compact assembly is ideal for applications where absolute dependability is required. It has a reliable operating life through hundreds of thousands of operations. Use is simplified by a pre-wired connector plug.

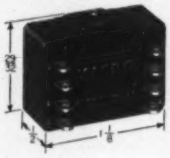
(*Send for Data Sheet 110*)

SUBMINIATURE SAFETY SWITCH DEVICE FOR HAZARDOUS EQUIPMENT



This MICRO SWITCH Subminiature door interlock switch assembly is designed for use as a safety device on such hazardous equipment as radio, radar, and X-ray cabinets. Installed on the cabinet door the switch automatically cuts off the power circuit when the service door is opened. Assembly shown uses a MICRO SWITCH Subminiature basic switch with single-pole, double-throw contact arrangement.

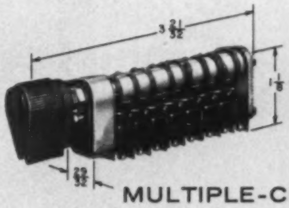
(*Write for Data Sheet 108*)



FOUR-CIRCUIT SWITCH FOR CONTROL OF COMPLEX CIRCUIT

Here is a four-circuit double-break switch for simultaneous control of four isolated circuits. This small switch is ideal in complex circuit applications where space and weight are prime factors in switch selection. Two snap-action springs are operated with each actuation of the plunger. This provides quick make and break of the contacts in each of the four double-break circuits. Electrical rating is 10 amperes 115-230 volts a-c; 10 amperes 30 volts d-c.

(*Write for Catalog 78*)

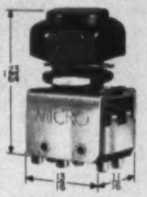


SUBMINIATURE ROTARY SELECTOR SWITCH FOR MULTIPLE-CIRCUIT CONTROL

This assembly is an 8-gang, 8-position rotary selector switch. It consists of 8 single-pole, double-throw Subminiature basic switching units operated by cams on a common shaft. Any combination of the 8 basic switching units may be actuated in any of the 8 positions if cams are set to specifications at the factory. Variations with from 2 to 8 single-pole, double-throw basic switches are available.

(*Write for Catalog 75 "Subminiature Switches"*)

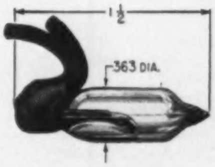
SEALED PUSH BUTTON SWITCH FOR PANEL MOUNTING APPLICATIONS



This MICRO SWITCH push button switch for panel mounting is outstanding because of its very small size and ease of installation. After the push button is mounted on a panel, the switching unit can be wired and then easily snapped into place on the end of the button assembly behind the panel. In addition, the push button is sealed to keep dirt and moisture from penetrating to the back of the panel. Switch has operating force of 3 lbs., weighs but .05 lbs.

(*Write for Catalog 75 "Subminiature Switches"*)

SMALL HONEYWELL MERCURY SWITCH MEETS SMALL LOAD CIRCUIT DEMANDS



The small Honeywell Mercury Switch shown here is especially designed for reliable service in low-energy circuits. This switch meets the requirements of applications where space and economy are critical factors. Mercury switches are widely used in animated displays, control and indicating devices, home freezer units, alarms and hundreds of other tilt-motion, low-force applications. Ratings available down to micro-volt, milli-ampere ranges.

(*Write for Catalog 90 on "Mercury Switches"*)

MICRO SWITCH, a division of Honeywell, is the pioneer in the manufacture of precision snap-action switches.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

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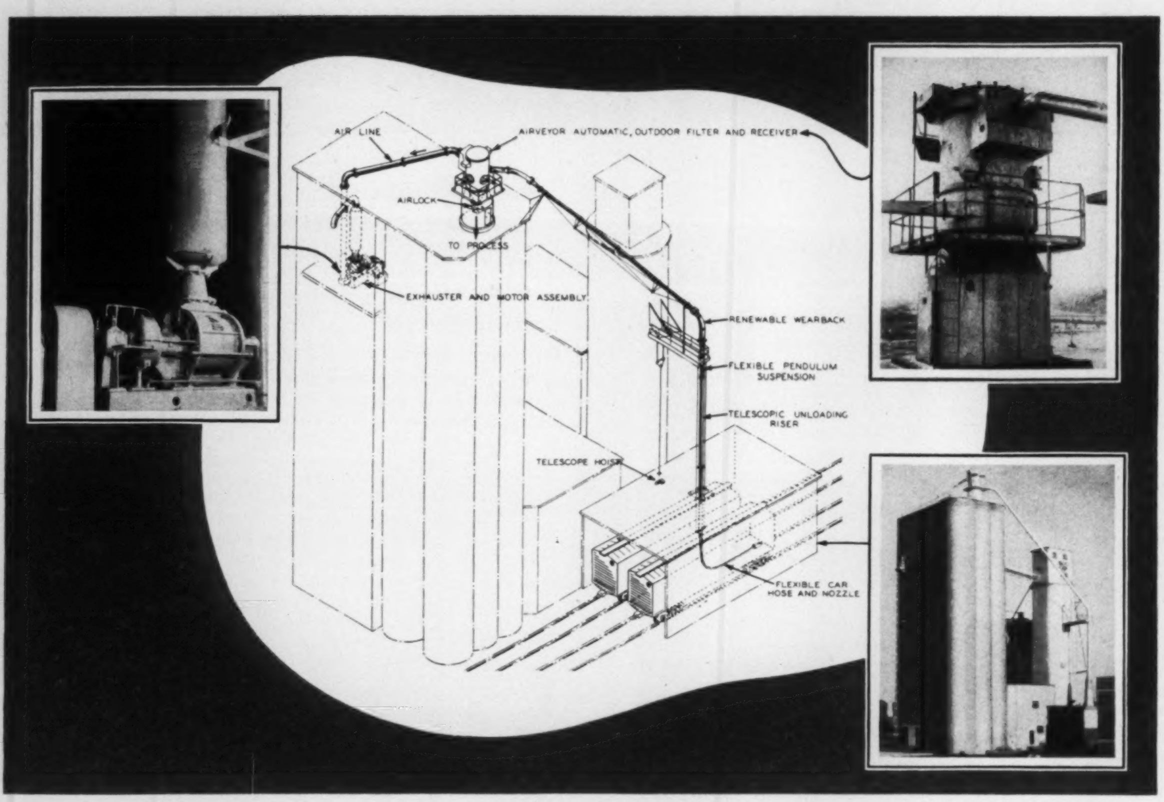
AIR LINE
AIRVEYOR AUTOMATIC, OUTDOOR FILTER AND RECEIVER
AIRLOCK
TO PROCESS
EXHAUSTER AND MOTOR ASSEMBLY
RENEWABLE WEARBACK
FLEXIBLE PENDULUM SUSPENSION
TELESCOPIC UNLOADING RISER
TELESCOPE HOIST
FLEXIBLE CAR HOSE AND NOZZLE

Airveyor system for unloading soybean meal, cottonseed meal, distillers' grains and other ingredients from cars to storage silos in a midwestern feed mill.

The AIRVEYOR serves many industries . . . and serves them well

A few of many materials handled by the Airveyor

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- Bauxite
- Borax
- Calcium carbonate
- Calcium phosphates
- Catalysts, petroleum
- Cellulose acetate
- Cereals
- Detergent powders
- Dicyandiamide
- Eggs, dried
- Feed ingredients
- Feeds, soft
- Fertilizers
- Flaxseed
- Flour
- Gluten meal
- Gypsum (raw or calcined)
- Lime, hydrated
- Lime, pebble
- Lime, pulverized
- Magnesium oxide
- Malt
- Milk, dried
- Mineral wool
- Nylon Pellets
- Polyethylene
- Resin, synthetic
- Rice
- Rubber pellets
- Salt
- Salt cake
- Semolina
- Soda ash
- Sodium phosphates
- Sugars, refined
- Talc
- Titanium dioxide
- Wood chips
- Wood flour
- Zinc oxide

The Airveyor pneumatic conveying system is noted for its ability to handle a large variety of materials in an efficient and sanitary manner . . . providing substantial savings in unloading from cars, trucks, ships and barges. It is also used with equal success for in-plant conveying.

For over 30 years the Airveyor has been raising standards of efficiency, replacing outmoded and out-worn methods of moving materials. Savings will quickly pay first cost. Loss of materials is eliminated, likewise dust and explosion hazards.

The average Airveyor system is a one-man operation. Systems can usually be installed with no stoppage of operations. Conveying ducts can be installed where desired—across streets, through and around buildings, or underground—the shortest distance to points of delivery.

Fuller experience in harnessing air to move dry-bulk materials covers a wide variety of applications. Why not put this experience to work for you. We'll be glad to make a study of your operation, without any obligation whatever, and submit our ideas for your approval.

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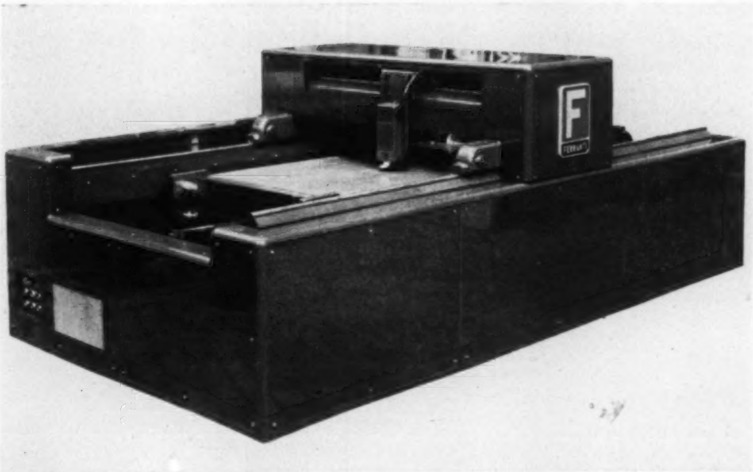
Circle 578 on Inquiry Card

notes from britain

By **FRANK G. WOOLLARD**
British Correspondent



Either a pen or a small diameter, high speed routing cutter can be fitted to the head of this numerically controlled machine. Developed for the aircraft industry by Ferranti Ltd., Edinburgh, the machine can prepare drawings or actual templates from control signals contained on magnetic tape. The machine consists essentially of a framework and a lofting table with a carriage that moves the length of the table; a traversing head on the carriage moves at right angles to carriage movement. The machine illustrates the widening area of application of numerically controlled equipment.

Interest Sparks Developments

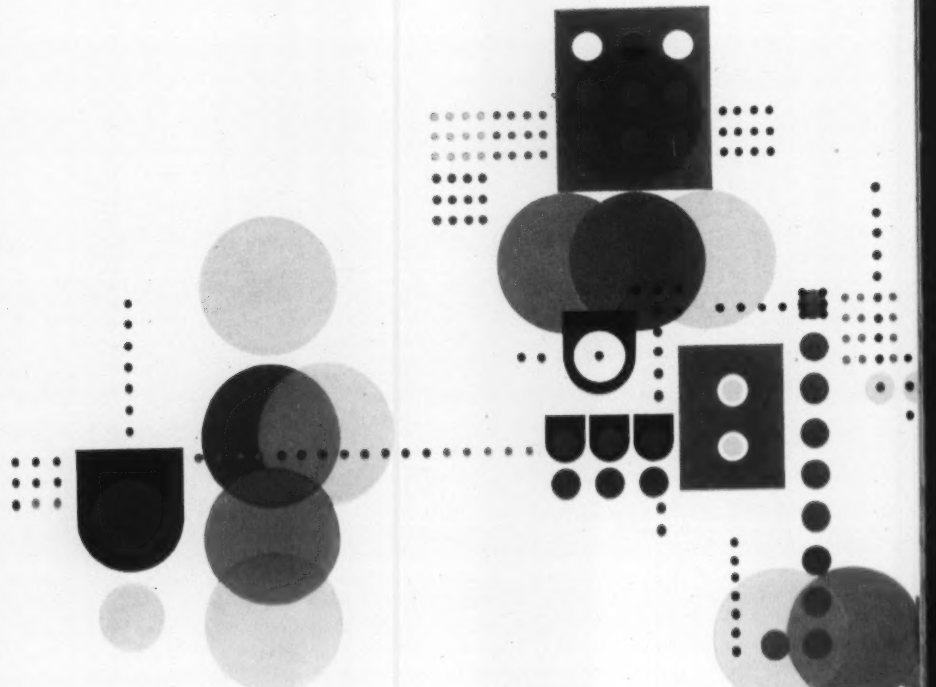
EIGHTEEN months ago the word "automation" struck the British public with all the force of a tornado. Until that time it was a term only used by engineers and those who had installed or were considering the use of automatic methods. This is a curious fact since there was a long history of automation in the British process industries, and transfer machinery and similar automatic methods had been adopted by the automobile industry for, at least, a decade. Then, fostered by the press, the word "automation", quite suddenly, became the common coin of everyday conversation.

The reason for this quickened awareness can be ascribed to two main influences: (1) the great interest taken in the reports of Walter Reuther's fight for the Guaranteed Annual Wage and (2) a conference held, in June 1955, by the Institution of Production Engineers, the theme for which was "The Automatic Factory—What does it mean?" Many members thought that this conference would be a fiasco but, in the event, it proved to be the most successful ever held by the institution. There was a record attendance and every paper delivered was fully and eagerly discussed.

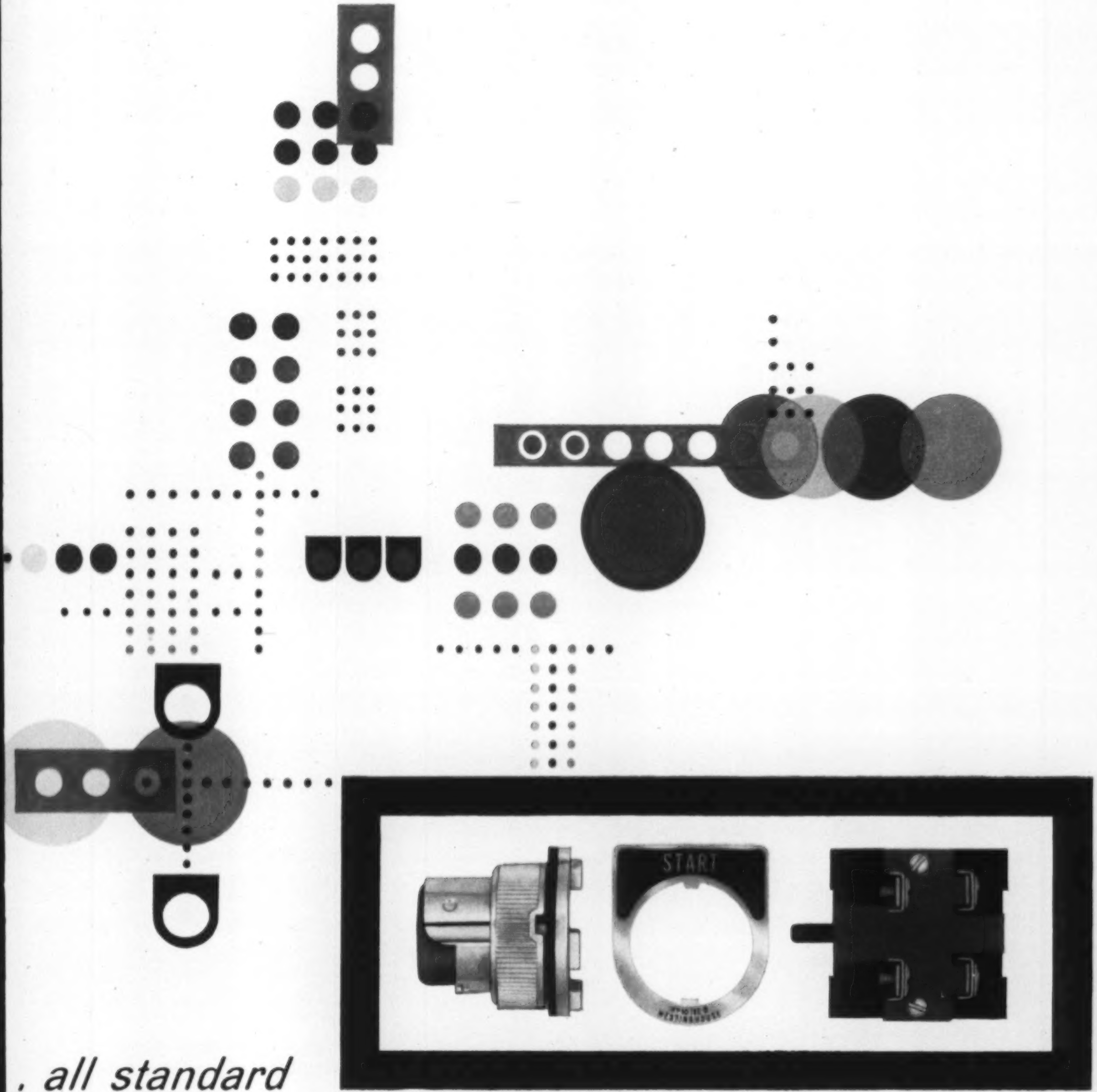
In addition to giving stock market news, the *Financial Times* is a journal of ideas and gave both these items due publicity. Other papers seized on, what was to them, a new word and rushed into print with some astonishing stories. Some of the less responsible prophesied a new Utopia of pushbutton industries with high wages and little or no work. Others prophesied dire distress—with robot employees, mass unemployment and too many goods chasing too few buyers. There was, of course, the inevitable attempt to import politics into this purely industrial matter. This became more apparent when, owing to the recession in the automobile industry, two companies decided to discharge a large number of employees and found themselves confronted with strike action. A section of the press described it as an "automation strike" and some members of the public believed this to be true despite plain evidence to the contrary. By now, however, the situation is quiet and the good sense of the employees, guided by the responsible leaders of the Trades Unions, has reasserted itself.

A Real Interest Exists

Despite all the effervescence, a very solid interest is taken by all manufacturers, great and small, in the possibilities of automation. This is shown by the enormous demand for lectures on the subject. On the average the writer, who is only one of many, has addressed two meetings a week for the past eighteen months and has had to disappoint nearly as many again. The meetings have been widespread, ranging from Aberdeen in the North to Portsmouth in the South, and from Grimsby in the East to Plymouth in the West. Many of these meetings have been promoted by the British Productivity Council—which was formed to carry on the work of the Anglo-



Pushbutton control arrangements almost to infinity . .



. *all standard*

How'd you like a stock of 1,500,000 pushbutton controls on hand at all times for original equipment needs or for production purposes?

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We don't make CADILLAC air cylinders and we don't pretend that we do . . .

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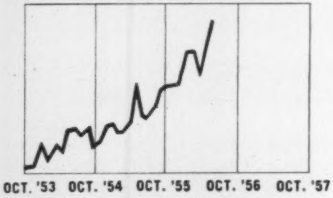
BORE	BASIC PRICE	ADD PER " OF STROKE
1⅛"	$15.50	$.35
1½"	$20.50	$.50
2"	$25.50	$.55
2½"	$29.50	$.65
3"	$32.50	$.95
4"	$47.50	$1.20

We furthermore claim that we work hard to ship from stock and our sales chart tells us that we are being successful on all accounts —
PRICE, QUALITY, SERVICE.



Besides cylinders, we also make the ALLENAIR line of AIR VALVES, AIR CLAMPS and DIAL FEED TABLES and if we could tell you right here all there is to tell you about what we offer and how those products can increase your PRODUCTION at MINIMUM COST we wouldn't need the $1.25 24-page catalogue that is available for free this month to anyone seriously interested.

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P.S.—*The cylinder pictured is a Factory Reject. The only rods available are straight ones and made out of #416 Stainless Steel ground and polished stock and repolished after machining. The bearing is nylon.*

The answer to the question on top of this page is: *Not one bit. There is a market for both!*

ALLENAIR **THE A. K. ALLEN CO.**
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American Council on Productivity—others by the universities, colleges of technology and the engineering institutions.

Small Firms Represented

The questions asked at the meetings are very much to the point and particular interest is displayed by representatives of the smaller firms. There is considerable evidence that these smaller companies are willing to adopt the new methods. They tend to start with the purchase of special-purpose machines, of the simpler types, which incorporate unit operating heads that are designed for linear or rotary transfer machines. These, at first, will be loaded and unloaded by manual operation; but the idea of automatic loading and control is too attractive to be resisted and so the movement towards automation grows. Naturally the conveyor method is much in evidence particularly in the process industries and the advent of the "stop and go" conveyor with mechanical, electromechanical or electronic control devices is helping to develop this form of automatic operation. Automation is now being applied to heat-treatment equipment and automatically controlled continuous furnaces are making headway in such ancient industries as pottery and china thus providing the uninterrupted flow of production which was impossible with the old type kilns.

The "big five" automobile firms are, in spite of the recession, pressing forward with their expansion schemes which in all cases include the installation of more automatic plant; some of this equipment is being imported because the deliveries from home-base machine tool builders may be anything up to two years.

Published Material

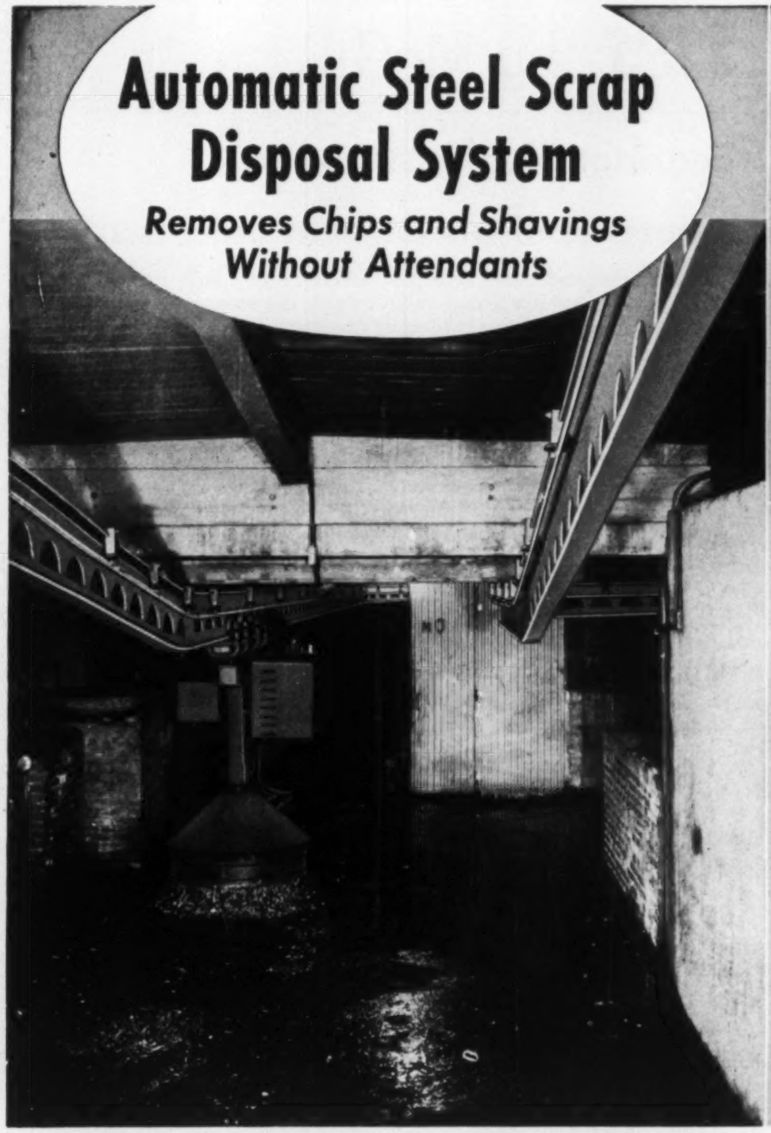
So far there have been only a few British books on automation so a brief review may be of interest. The Department of Scientific and Industrial Research has issued through H. M. Stationery Office a book entitled *Automation*—a report of technical trends and their impact on management and labor. Another book *Automation—Friend or Foe?* by R. H. Macmillan of the Department of Engineering at the University of Cambridge deals largely with control systems in which the author is expert. His earlier work *An Introduction to the Theory of Control* is now in its second edition. *Automation in Theory and Practice* published by Basil Blackwood of Oxford is a report of a course of lectures organized by E. M. Hugh-Jones, a Fellow of Keble College. It deals with technical, economic and social aspects of automation and includes lectures on administration and on the Trade Union aspect. Dr. Paul Einzig has written an extremely useful volume on *The Economic Consequences of Automation* published by Martin Secker & Warburg of London which is both sound and readable.

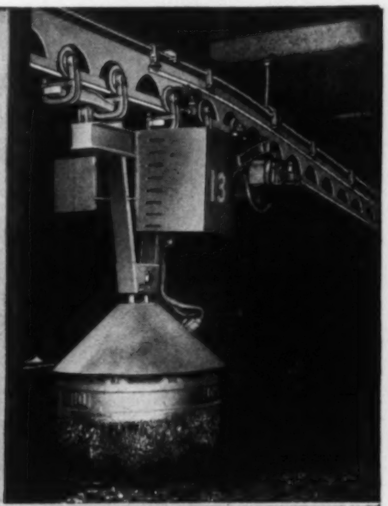
Much of the practical information comes from the technical journals and the most informative is *Metalworking Production*, a publication which appears weekly. Just now it carries a series of articles on metal-working and machinery in Russia which includes much about automation. Among the monthlies, *Machinery* provides some valuable information; while *Mechanical Handling* deals with automation which depends upon conveyors and the like. *Instrument Review* keeps industry fully informed on instrumentation. A new monthly has just appeared under the style of *Automation Progress* and *Automation Age*, issued first as a broadsheet is now a fully fledged journal with the new title *Automation and Automatic Equipment News*. There are several journals devoted to electronics—these are rather specialized. As previously noted, that well-known daily—the *Financial Times* provides a valuable service in reviewing automation and in July of last year published a survey called "Electronics and Automation". Other journals publish occasional articles but the foregoing give most of the news. Among the professional groups the Institution of Production Engineers is the most active in the automation field and papers appear on this subject every month.

This then is the general background of automation in Britain today. In succeeding articles I will deal more specifically with automation in practice.

Automatic Steel Scrap Disposal System

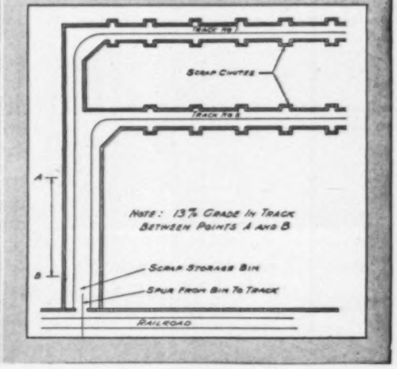
Removes Chips and Shavings Without Attendants





View of tracks near beginning of tunnels. Carrier is shown approaching track incline on way to bin with a load.

A load of scrap about to be dropped in bin. Carrier immediately reverses after unloading and starts another trip.


Track No 1
Scrap Chutes
Track No 2
A
B
Note: 13% Grade in Track Between Points A and B
Scrap Storage Bin
Spur from Bin to Track
Railroad

ONE carload of metal chips and shavings is picked up and moved daily with an automatic Cleveland Tramrail magnet-carrying system that operates unattended in two parallel tunnels under metal-working machines.

Each tunnel has its own Tramrail track on which a magnet carrier travels back and forth, picking up scrap that comes down from the machines on floor above. The scrap is conveyed to a bin next to a railroad siding. The system was put into operation in 1942 and has proven an extremely efficient and low-cost method for ferrous scrap disposal.

Cleveland Tramrail
Engineering and Application Data

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CLEVELAND TRAMRAIL DIVISION
THE CLEVELAND CRANE & ENGINEERING CO.
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CLEVELAND TRAMRAIL

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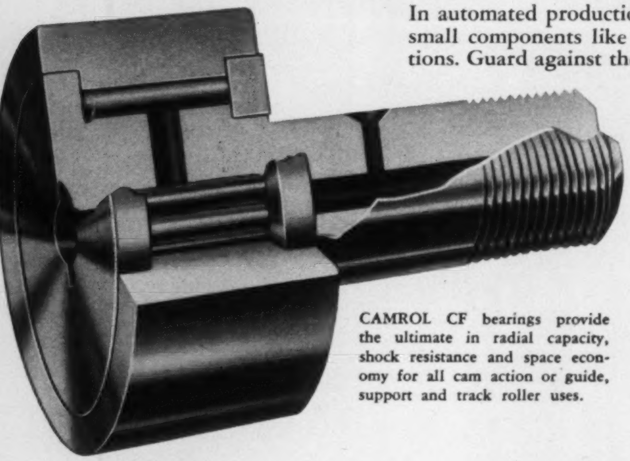
AUTOMATION TIPS by McGill

CAMROL bearings ideally suited to anti-friction requirements of automated machinery

TRADE MARK

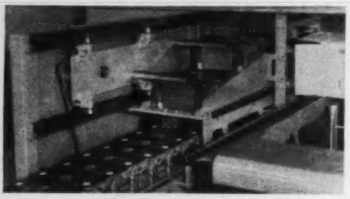


CAMROL CF bearings provide the ultimate in radial capacity, shock resistance and space economy for all cam action or guide, support and track roller uses.

In automated production, even the inefficiency and faulty operation of small components like a cam follower unit can cause costly interruptions. Guard against these failures by specifying CAMROL cam followers. Their quality insures dependability. Their design simplifies lubrication, easily accommodates critical loads and provides low starting and running friction.

Over 20 years of engineering development has gone into the McGill bearing — the first commercial full-type roller bearing cam follower. McGill has employed the advantages of these years of application experience to improve the design and build performance extras into the CAMROL CF, CYR and sealed SCF and SCYR series bearings. All are available in a wide range of standard sizes.

The applications cited below are just a few of the many instances where CAMROL bearings are adding to the dependability of automated machinery.

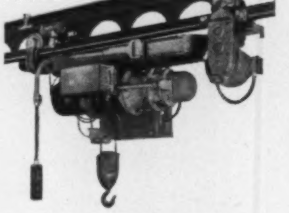


Camrol CF bearings cut power requirements on J. L. Ferguson Co. packaging machines

Used as load-carrying cam followers and as guide rollers in PACKOMATIC packaging machinery, McGill CAMROL CF bearings have brought several desirable advantages to J. L. Ferguson Company in the eight years this firm has relied on CAMROL bearings.

The CAMROL CF bearings eliminate wear by reducing friction. This reduces power requirements and smooths the operation of these machines. The CF bearings are standard, cost less and are more easily applied than previous assemblies.

For trouble-free operation, up to 50 bearings per machine are now used by this company.

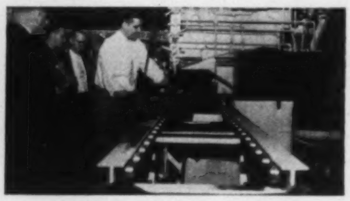


Cleveland Tram Rail guides motor heads on McGILL Camrol Bearings

Motor-driven electric hoist carriers made by the Cleveland Tramrail Division of the Cleveland Crane and Engineering Company, incorporate McGill CAMROL Cam Follower bearings as side guide rollers for the motor head.

Replacing spring loaded friction type bolt or roller units, the CAMROL cam followers provide dependable, free running operation of the carrier assembly and provide simplicity of mounting and lubrication with trouble-free performance.

Bearing performance has been most satisfactory through almost six years of use.



Camrol CF bearings provide friction-free track rollers for automatic mold blower

McGill CAMROL CF rollers are used as track rollers to form a mold conveyor in the Beardsley & Piper MBS-20 Mold Blower. The CAMROL CF bearings replaced built up friction rollers in this application. Although the duty here is rather light and the speeds slow, the cam follower bearing provides less starting and running friction. This helps speed the even flow of work from the machine, which must be fast and automatic. The compact unit, with integral stud, simplifies assembly and lubrication. Availability of a standard bearing is more convenient and less costly.

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MULTIROL® GUIDEROL® CAMROL

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AUTOMATION

FEBRUARY 1957

Standing Still

Basically, automation is an aid to productivity. Unless it increases output and lowers cost it offers little value. However, over the past few years many people have expressed concern over its inherent "radical productivity increases" and elimination of jobs. A look at the latest facts proves interesting.

Silhouetted against a backdrop of the greatest employment level in history and the highest gross national product, is the new perspective made by wage rates and prices today. In their latest quarterly review the Chase Manhattan Bank pointedly observed:

"Experience shows that, over long periods, manufacturing wage rates rise faster than industrial prices. This fact, of course, is one of the important reasons for the long-term rise in living standards. In the past four decades, average hourly earnings in manufacturing have multiplied seven times (in dollars not adjusted for changing prices). In the same period, industrial prices have multiplied 3½ times. Increases in productivity (output per man-hour worked) have made it possible for wage rates to rise twice as fast as prices. Output per man-hour in manufacturing about tripled between 1914 and 1955.

"When you look at the record over shorter periods, the inter-relationship betwen wages, productivity and prices is equally striking. Between 1939 and 1947, wage rates went up 95 per cent while output per man-hour rose only 8 per cent. Unit labor costs increased by 73 per cent and industrial prices moved up 64 per cent. In contrast, the rise in productivity matched that in wage rates from mid-1951 to mid-1955. Unit labor costs did not change—and neither did industrial prices.

"Since mid-1955 manufacturing wage rates have moved up from $1.87 to $2.00, or 7 per cent. Output per man-hour has shown very little, if any, increase. As a result, industrial prices rose 5 per cent during the past year. At present, then, we are in a phase where wage rates seem to be outrunning productivity. The hope is that productivity will resume its advance in the period ahead and help dampen the pressure on industrial prices."

Commerce Department statistics show that two-thirds of the 35 billion dollar investment last year in plant expansion was earmarked for machinery and equipment. The considerable quantity of automated equipment represented in this investment obviously is doing little more than helping hold the line. Automation can effectively renew the advance in productivity. But it takes time. Considerably more research, engineering and management effort is necessary in the race to keep up with expanding markets and dynamic economic growth. More automation is the answer.

EDITOR

The ancient Greeks had an expression: "Χαλεπὰ Τὰ Καλά," —"the beautiful is difficult." Although not everyone is privileged to see the beauty in automation, certainly everyone can appreciate the difficulty in making automation a reality. This case history attests to that difficulty. And there is beauty in the benefits to management, to labor and to the public.

MANUFACTURING ENGINEERING AT WORK

By **L. J. MOELLER**
Assistant Superintendent of Manufacturing Engineering
Point Breeze Works, Western Electric Co., Inc.
Baltimore, Md.

IN THE MANUFACTURE of any product for a competitive market, design and processes used for its manufacture must be balanced between quality and cost. The ideal combination is, of course, very high quality and very low cost, but this goal can seldom be reached. Amazing results can often be realized, however, when manufacturing or production engineering is recognized and permitted to play its key part in the planning and preparation for manufacture. In this article some of the major aspects of manufacturing engineering will be discussed.

It may be argued that most products are not manufactured in large enough quantities to be considered volume-production items. However, the quantities to be manufactured need not be large to secure many of the benefits of large-scale production. Designs can be simplified to reduce them to the bare essentials and to see that each essential is standardized in every possible respect. Use of existing standard components secures two advantages. Thoroughly proved components assure reliability of the product and additional demand for a component can result in reduced cost of the component. Many of the tools and processes developed for large-scale production can also be adapted later to low-production products.

The manufacturing engineer's job is to devise ways and means to produce the end product at the required quality level, at the least possible cost and at the time needed. Obviously, the product must satisfactorily perform the functions for which it was designed, but to build unnecessary quality into it will only increase its cost without adding to its usefulness. Delays in making the product available may force customers to find a substitute or suffer serious financial losses. The profits and reputation of the manufacturer of the product are also at stake. Fulfillment of all these requirements is of maximum importance on any volume-production job because of the large sums of money that may be required for the manufacturing facilities. Volume production involves more than manufacture and assembly of parts. It involves careful design of the product, thorough planning and engineering of manufacturing processes and expert management.

The secret of the high standard of living in this country is said to be based on a volume or mass production economy. This idea has been so widely advertised, here and abroad, that it is hard to see why there should be any secret about it unless the secrecy concerns production methods rather than their results.

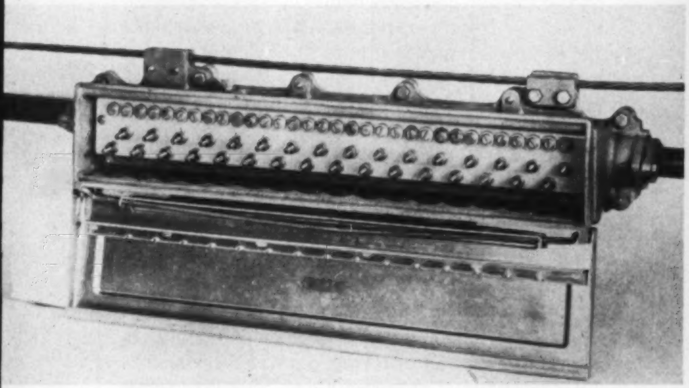


Fig. 1—Telephone cable terminal using polyester resin terminal block. This terminal was designed to replace an older model because of moisture penetration, and to improve production techniques for a requirement of several hundred thousand terminal blocks a year.

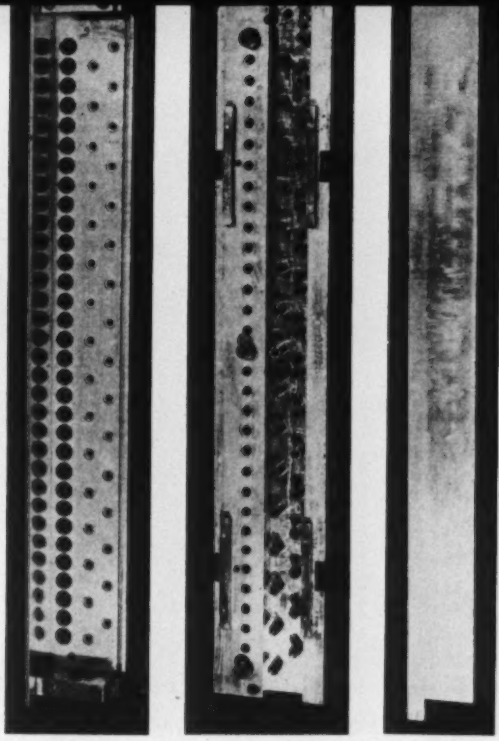


Fig. 2—Experimental permanent steel mold for forming polyester resin block. Excessive internal stresses result from holding inserts in position as the blocks are cured—due to the high shrinkage factor of the polyester resin material. Therefore, this molding technique was abandoned.

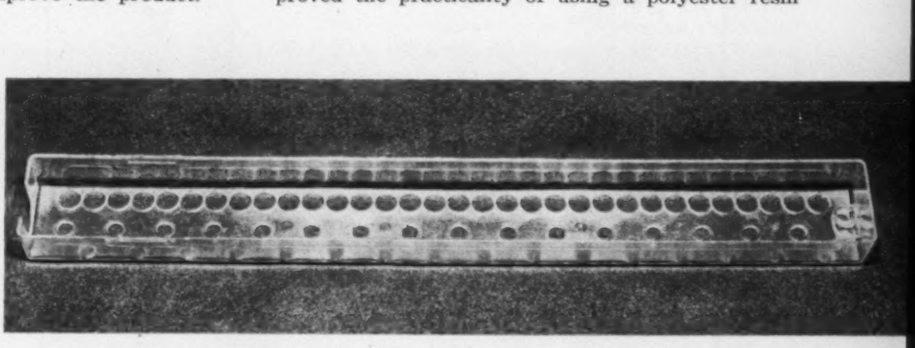
▶ Production Example

Application of volume-production principles can be best demonstrated by using a specific example. A cable terminal manufactured at the Point Breeze Works of the Western Electric Co. has been chosen for this, partly because its design is relatively new and takes advantage of recent advances in manufacturing methods and partly because new and unique materials are used in its construction, *Fig.* 1. These cable terminals are used for connecting the wires from telephone users' premises to the aerial distribution cables from the telephone exchange. We shall review the manufacture of these cable terminals as a process covering the major steps from the design of the product, through engineering for manufacture, procurement of materials, manufacture and eventual shipment to the customer. This review will bring out how well the process and facilities demonstrate the principles of volume production. It will also point up the relationship between cost of manufacture and the methods used. We will consider some of the problems met during the engineering of the plant and process to show how the principles of volume production were applied to reduce costs or improve the product.

Improvement in cable terminals is a continued aim of Bell Telephone Companies to decrease service difficulties. Penetration of moisture into the aerial cables through the older style terminals was the problem which instigated this particular project. These older terminals were filled with asphalt compound to seal them against moisture. It was extremely difficult to keep these terminals moisture tight under the extremes of heat and cold to which they were exposed. When casting resins were developed and became commercially available, it was believed that they might be suited for the manufacture of moisture tight cable terminals because of their favorable physical characteristics and electrical qualities and their ability to withstand wide temperature changes.

After early laboratory development work had proved the practicality of using a polyester resin

Fig. 3 — Compressible polystyrene mold for forming polyester resin block. This mold bonds to the block and is sufficiently compressible to permit movement of the inserts as the block shrinks. Since method is also more economical than the permanent steel mold method, this mold was adopted.



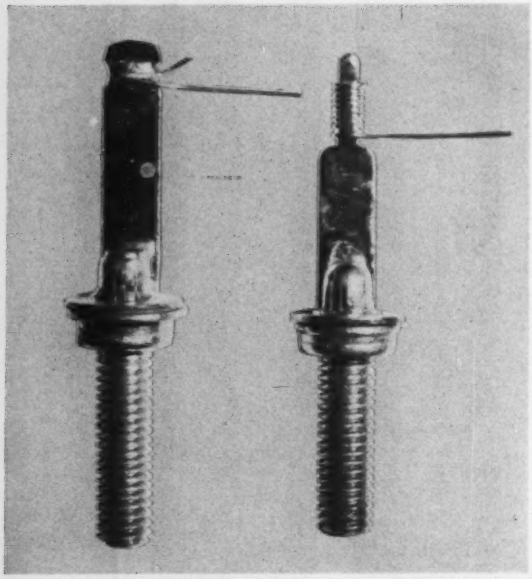


Fig. 4—Standard soldered connection compared to the solderless mechanically wrapped connection. This wrapping method promises to solve the production handicap and tendency toward poor quality found in production soldering systems.

compound for the terminal block, a new line of aerial cable terminals was designed by the Bell Telephone Laboratories. In these new terminals the end of a short piece of telephone cable was to be inbedded in a polyester resin compound block. The ends of the cable conductors were to be soldered to terminals which were to protrude from the face of the cast resin block. It was hoped that the bond between the cast resin block and the imbedded parts would provide an adequate moisture seal for the terminal assembly. Since many aerial telephone cables are operated under nitrogen gas pressure to reduce the possibility of moisture getting into them, the new cable terminals were also required to be gas pressure tight.

▶ Pilot Manufacturing Line

Upon receipt of the design specifications, it was immediately evident to Western Electric's manufacturing engineers that a considerable sum of money would be required for facilities to manufacture the predicted requirement of several hundred thousand terminals per year. Having had little experience in the volume use of polyester resin compounds, it was decided to set up a preliminary pilot manufacturing line on which the various processes involved could be perfected and manufacturing difficulties could be determined and overcome before the planned large-scale facilities were procured and installed.

Initial designs called for use of permanent steel molds, *Fig.* 2, into which the terminals and the end of the telephone cable could be positioned. About 600 permanent steel molds costing $400 each would be required to produce the terminal blocks at the required output level. This meant an investment of $240,000 would be required for molds alone. With an expected life of three years, the mold cost by itself would be about $0.38 per block, plus about $0.20 per block for cleaning and assembling the molds each time they were used.

The steel molds were filled with catalyzed polyester resin compound with the complete assembly to be placed in an oven for curing the resin block. Immediate results showed that the yield of good blocks from this method was prohibitively low, since the imbedded parts were held rigidly in place in the mold and cracking occurred during the normal shrinkage that takes place when polyester resin compound is cured. This low yield of good blocks would naturally bring higher costs. The shrinkage cracking had to be eliminated.

To overcome the shrinkage difficulty, a compressible polystyrene mold, *Fig.* 3, in the form of a shell was developed. With a compressible polystyrene shell the imbedded parts could move as the block shrank during curing, eliminating the shrinkage cracking losses in the blocks. The polyester resin block was found to adhere rigidly to the polystyrene shell. With the polystyrene shell left in place, surface electrical characteristics of the assembly are also improved. Since the polystyrene shells can be purchased for about $0.20 each, this alternate method of producing the terminal has a cost advantage over the steel molds in addition to solving the cracking problem.

Still another major problem was encountered in the pilot shop. The filled polyester resin compound did not adhere to the cable conductors and other metal inserts sufficiently to provide a gas pressure tight assembly in all cases. Many differ-

Fig. 5—Automatic electrical test set for checking circuit continuity, high voltage breakdown and insulation resistance between circuit components.

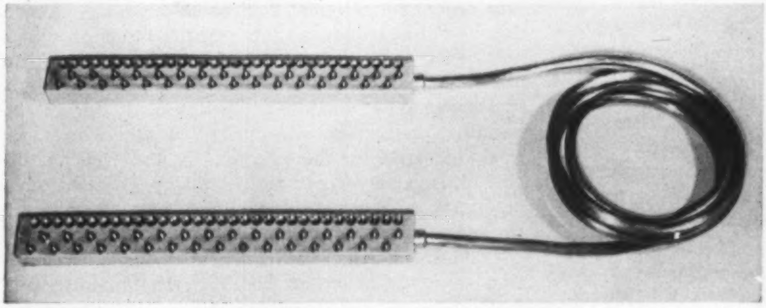


Fig. 6—Manufacture of terminal blocks in pairs facilitates testing since contact fixtures can be used to complete test circuits. After testing, the pairs are separated into single terminal blocks. This method reduces electrical testing time by 95 per cent.

ent ideas for improving the seal were tried until one was found that was satisfactory. A good seal was obtained when the imbedded metal parts were given a thin coating of unfilled polyester resin compound to which a mild etching agent had been added. The thin film of resin adhered firmly to the metal parts and the filled polyester resin compound bonded securely to the resin film.

In these cable terminals each of the imbedded cable wires must be attached to the end of a terminal screw to provide the necessary electrical connections. The conventional way of attaching wires had been to wrap the end of a wire around the end of a terminal with pliers and then solder it in place. In view of the many million connections that would be required per year on this product, it was decided to investigate other means of attaching wires to terminal screws. Mechanical gun wrapped connections recently developed by the Bell Telephone Laboratories and the Western Electric Co., *Fig.* 4, required no soldering and were found to be entirely satisfactory in these assemblies (see AUTOMATION, May 1956, Pg. 40). They substantially lowered costs over hand wrapping and soldering. The apparatus design was accordingly changed to incorporate this method of attaching wires to terminals.

▶ Automatic Testing

Because these assemblies are to be used in the public telephone system where trouble-free service is important, they must meet stringent electrical requirements. Automatic testing equipment was developed for checking all electrical connections, to make a high voltage breakdown check between all insulated metal parts, and to check the insulation resistance between all elements of the electrical circuits, *Fig.* 5. To facilitate testing, the terminal blocks are made in pairs—a unit is attached to each end of a piece of telephone cable, *Fig.* 6. By this arrangement, simple contact fixtures can be used to connect the terminals to the test equipment whereas if they were made as "singles", it would be necessary to manually connect from 20 to 52 color coded wires to specific terminals on the test equipment. After testing in pairs, the cable stub is cut in the center thereby making two individual terminal blocks, each connected to its own piece of cable. The cost of testing these blocks as "pairs" is approximately 1/20 the cost of testing each block individually.

Water testing tanks were originally planned for gas pressure tests, but it was found that testing in water was not only messy but was extremely slow. To eliminate these disadvantages, automatic helium testing equipment utilizing a commercial mass spectrometer was developed, *Fig.* 7. Use of this new test equipment reduced the cost of pressure testing by at least 50 per cent over water testing methods in spite of the relatively high cost of mass spectrometers.

▶ Process Analysis

Each step in the entire manufacturing process was analyzed carefully and the most efficient arrangement was determined for each step, taking

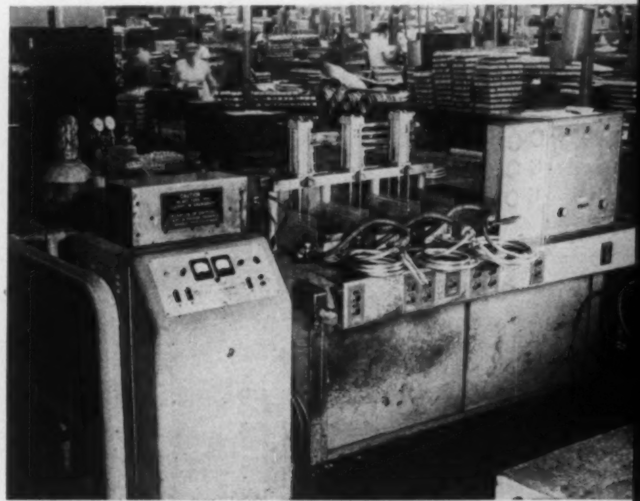


Fig. 7—Mass spectrometer test equipment using helium gas for leak detection. Cable terminals must be gas pressure tight because many terminals are operated under nitrogen pressure to reduce the possibility of moisture penetration.

into account equipment cost, probable maintenance expense and associated labor cost. When this had been done and manufacturing difficulties on the pilot line had been overcome, the full scale plant facilities were installed. Mechanical means of handling materials were provided wherever they were required by the process, by the weights involved, or where their cost could be justified on a labor saving basis. The facilities provided are arranged as shown in *Fig.* 8.

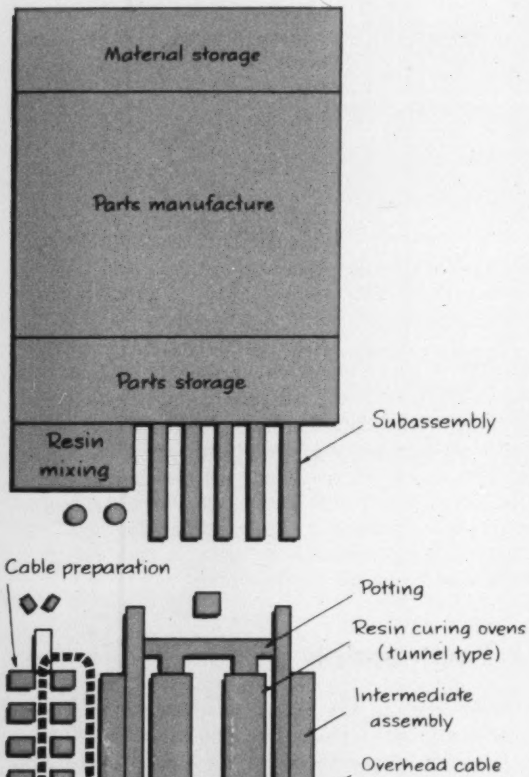

Material storage
Parts manufacture
Parts storage
Subassembly
Resin mixing
Cable preparation
Potting
Resin curing ovens (tunnel type)
Intermediate assembly
Overhead cable conveyor
Overhead cooling conveyor
Automatic testing
Subassembly conveyor
Final assembly
Sealer curing oven
Final inspection
Packing positions
Packing conveyors
Sorting area 16 varieties made concurrently

Fig. 8—Schematic layout of facilities for manufacture of polyester resin type telephone cable terminals. This installation was established after thorough study and investigation on pilot lines.

Concurrent with the procurement and installation of manufacturing facilities, the manufacturing engineers prepared complete instructions for the production department. These instructions included a list of all materials and parts to be purchased and specifications for the manufacture of the parts to be made. The instructions not only specified the machines and tools to be used but, whenever required, they specified how the equipment was to be used.

Upon receipt of these instructions, the production department ordered all materials and purchased parts and prepared a schedule for the manufacture of parts that were to be made. This schedule took into account the availability dates for the equipment and tools involved and the scheduled receival dates for the purchased materials. Production personnel were obtained and assigned in accordance with the planned production schedules. As parts were completed, they were programmed through the sub-assembly, intermediate assembly, final assembly, testing and packing operations.

Many of the items developed for this specific manufacturing process probably could not be justified if the terminals were not volume or mass-produced. However, now that these developments have been made most of them are readily adaptable to reasonably low levels of production. Some examples are: testing in pairs, gun wrapped connections, expendable plastic molds and the resin film for improving the bond between filled resin compounds and metallic parts. Analysis of these developments brings out into the open certain cause-and-effect relationships that manufacturing engineers cope with continuously. For example, testing these terminals in pairs reduced cost by a change in manufacturing process. Gun wrapped connections reduced cost by a change in product design. Use of expendable plastic molds improved quality and reduced cost by substituting a relatively inexpensive purchased item for expensive tools. The resin film on imbedded metallic parts improved quality and reduced cost by a product design change and a change in manufacturing process.

▶ Chance for Automation

Complete automation of a factory or shop would certainly be an ideal accomplishment. However, there are many limitations that make it impractical or uneconomical to even approach such a utopian arrangement. Automation has its best

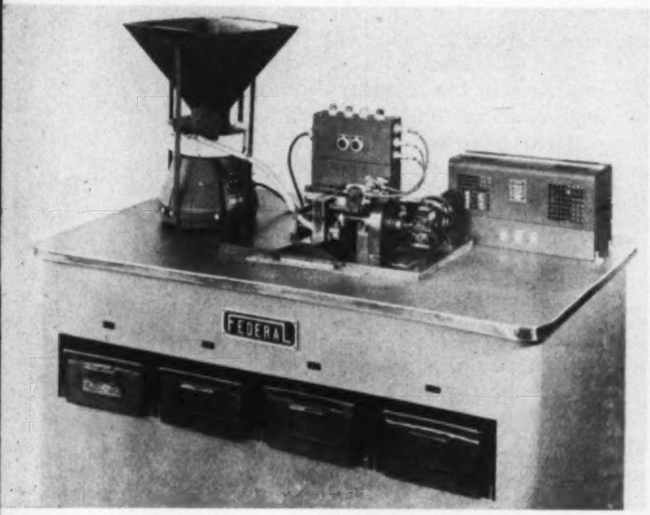


Fig. 9—Automatic gaging machine for sorting mechanical parts having critical dimensions. Unsorted parts are fed through a vibrating hopper. Trays beneath table-top contain sorted parts.

chance for success in a mass production environment. Since the production levels of these cable terminals were relatively high, automatic equipment was provided for many operations. Parts having critical dimensions are gaged in an automatic machine, *Fig.* 9. Many small parts are converted to subassemblies in automatic machines, *Figs.* 10, 11. Spark gap type high voltage protectors are assembled and tested in automatic machines, *Fig.* 12. All electrical tests and the gas pressure test are made in automatic type test equipment, *Figs.* 5, 7.

Operating cycle of the die casting machines for housings is automatic, including the transfer of precisely measured quantities of molten aluminum from the melting furnaces to the dies and the opening and closing of guards that completely enclose the die area of the machine. Even the scrap from the trim presses is returned to the melting furnaces by automatic vibrating conveyors. Automatic machines are used for drilling up to 25 and tapping up to 11 holes in some castings, *Fig.* 13. Castings are also cleaned automatically after machining. Use of this automatic equipment has resulted in substantially reduced labor costs and, in many cases, the quality of the product was improved as well.

In engineering for manufacture of these cable terminals, full consideration was given to elimination of hazards and improvement in working conditions for the employees involved. Every machine and operation was guarded to the maximum extent. Undesirable levels of heat, fumes and noise were eliminated. In addition, manual handling of materials was eliminated wherever it was practical to provide mechanical handling facilities.

It should be evident from this discussion that the manufacturing engineer can and should play an important part in industry. He is in the unique position of serving three masters. First, he serves the company for which he works by planning for the manufacture of the company's products at the lowest possible cost consistent with the desired quality level. This makes it possible for his company to thrive in a competitive market. Second, he serves the public by making it possible for his company to sell its products at the lowest

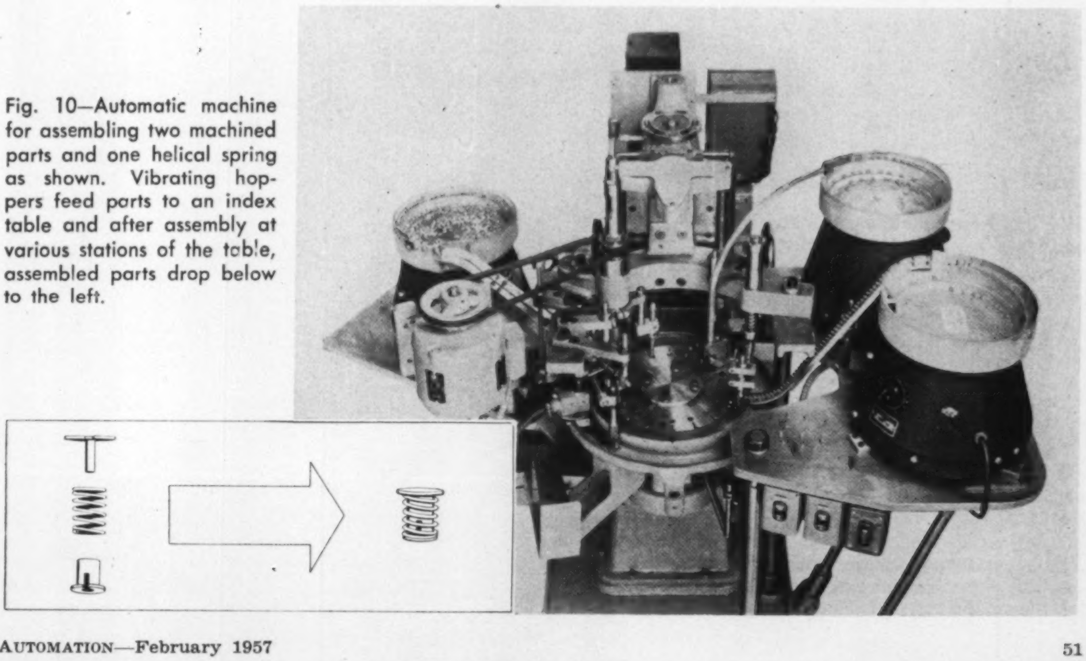


Fig. 10—Automatic machine for assembling two machined parts and one helical spring as shown. Vibrating hoppers feed parts to an index table and after assembly at various stations of the table, assembled parts drop below to the left.

possible prices. This helps the public improve its standard of living by being able to purchase more goods with the same income. Third, he serves the employees of the company for which he works by improving working conditions and reducing occupational hazards. This provides for greater employee satisfaction with his job which should reduce many of the causes for low employee morale.

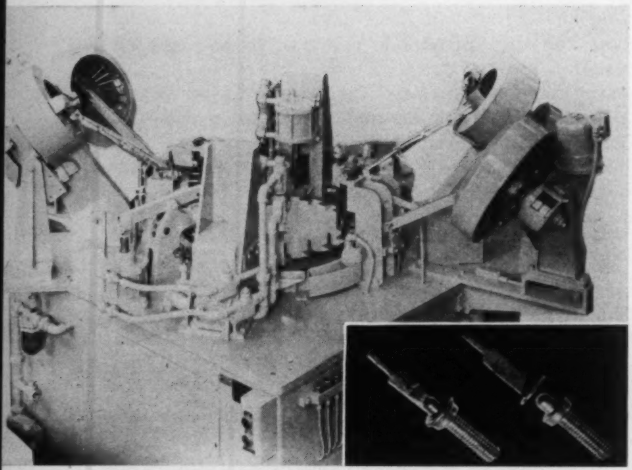


Fig. 11—Automatic machine for assembling terminals to special screws. This machine makes two assemblies simultaneously as evidenced by duplicate stations around the indexing table. Insert shows the two-part assembly performed by the machine.

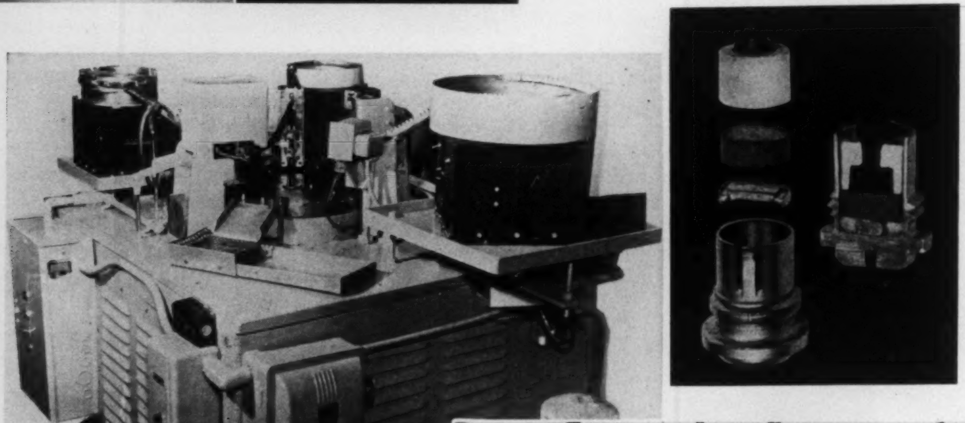


Fig. 12—Automatic machine for assembling and testing high voltage protectors. Assembly is shown in exploded and section views. Combined assembly and test eliminates intermediate handling problems.

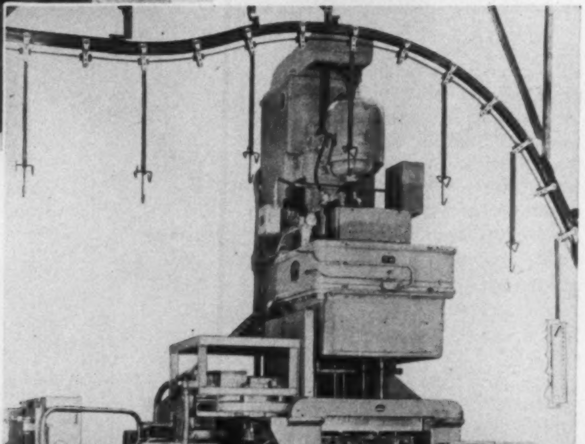


Fig. 13—Automatic Natco machine for drilling 25 holes and tapping 11 holes in aluminum die-cast housings.

TAPE CONTROLLED TABLE POSITIONING

AUTOMATION OF MEDIUM-SIZED production lots requires flexibility of the machinery with minimum time required to change over from one product to the next. Tape programing of machine tools is being developed in fulfillment of these requirements, since the use of tape offers automatic cycling features, yet such equipment needs little time to change tapes and be set up to run a different part.

An example of such equipment is the Arter Jigmatic spacing or positioning table, *Fig.* 1, which employs a punched tape to automatically locate work for consecutive operations at any position within a 20 by 30-inch area. This table, consisting of stacked cross-slides, was designed for under a 5-foot or larger radial drill. The console, containing a tape reader and control pushbuttons, is a separate unit and can be located at any position most convenient to the operator.

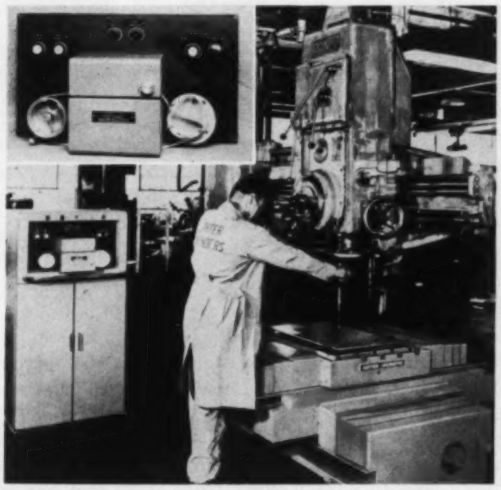


Fig. 1—Tape controlled work positioning table made by Arter Grinding Machine Co. shown mounted under a Fosdick radial drilling machine. Console at left controls *X* and *Y* co-ordinate positions of worktable. Insert shows arrangement of tape reader and pushbutton controls.

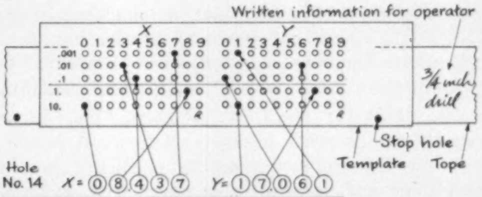


Fig. 2—Template provides hole pattern for punching one block of numbers in the tape. Block illustrated would cause the table to be positioned 8.437 inches from zero on the X axis and 17.061 from zero on the Y axis.

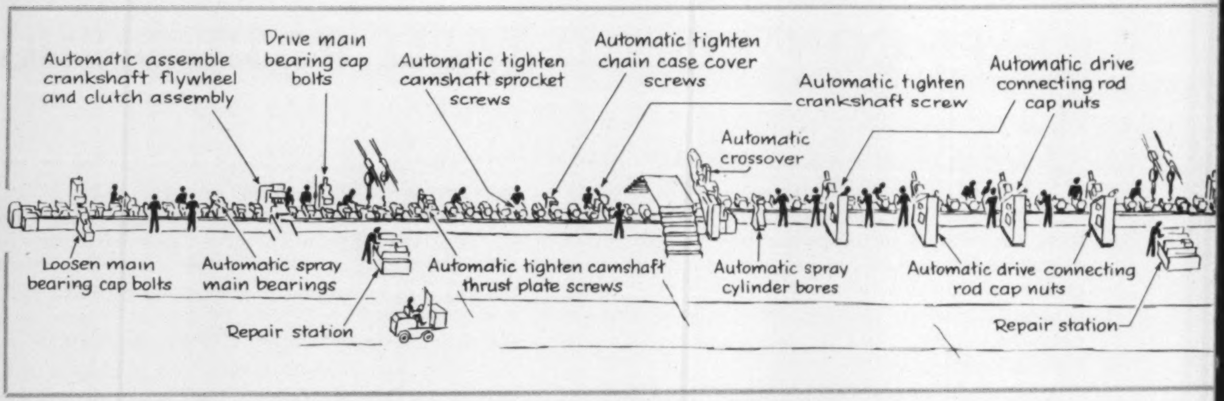
To prepare for production with this setup the engineering drawing of the product to be drilled is dimensioned with *X* and *Y* co-ordinate axes from a chosen reference point and all hole locations are listed, or charted, in a studied sequence. From the chart of co-ordinates the tape is punched with a template type hand punch, *Fig.* 2, which uses the decimal system wherein a hole is punched for each digit and thereby involves no coding or conversion of the information. One block of holes is punched for each position required. Each block includes a stop hole to properly position that group of holes in the tape reader. A roll of tape has capacity for 200 blocks of punches.

If two consecutive positions have the same co-ordinate on either axis a hole is punched in one of the places marked *R* on the template. In use this serves to repeat the value of that co-ordinate punched in the previous block by locking the associated slide against movement. Special information, such as tool changes, may be written on the tape between blocks of punched holes.

To operate the positioning table the completed tape is loaded into the tape reader. In use the tape is unwound from the inside of the roll and rewound on the outside, *Fig.* 1 *insert*. No rewinding operation is necessary. The *X* and *Y* axes are referenced to a hole in the lower right hand corner of the table which is the "0" position. The work is placed on the table against blocks which are located in machined slots. The inside edges of these slots pass through the center of the "0" position. The spindle of the radial drill arm is locked in position with reference to the center of this hole.

With the work clamped in position and the tape in its proper position, the operator pushes the *Position* button which moves the slides to the drilling location indicated by the punched holes. An *Out of Position* light now goes out and an *In Position* light indicates that the work is in position and the tables locked for the manual drilling operation. The cross-slides are clamped automatically by electromagnetic brakes. The machining operations are not controlled from the tape. While the drilling operation is being performed the tape automatically moves to the next hole-reading position. The operator can then read such instructions relating to the next operation as may have been written on the tape.

Upon completion of the cycle on a workpiece, successive workpieces of the same design can be machined by rerunning the same tape through the reader as often as desired. The arrangement described requires no jig-bushing plate and provides an additional advantage of automatically programing the sequence of manual operation, thereby eliminating errors of omission experienced with completely manual operation of this type of machine tool.


Automatic assemble crankshaft flywheel and clutch assembly
Drive main bearing cap bolts
Automatic tighten camshaft sprocket screws
Automatic tighten chain case cover screws
Automatic tighten crankshaft screw
Automatic drive connecting rod cap nuts
Automatic crossover
Loosen main bearing cap bolts
Automatic spray main bearings
Repair station
Automatic tighten camshaft thrust plate screws
Automatic spray cylinder bores
Automatic drive connecting rod cap nuts
Repair station

AUTOMATION TODAY

AUTOMATED ENGINE PLANT

By H. R. Bentley
Manager
Production Planning, Engine Division
Chrysler Corp.
Detroit, Mich.

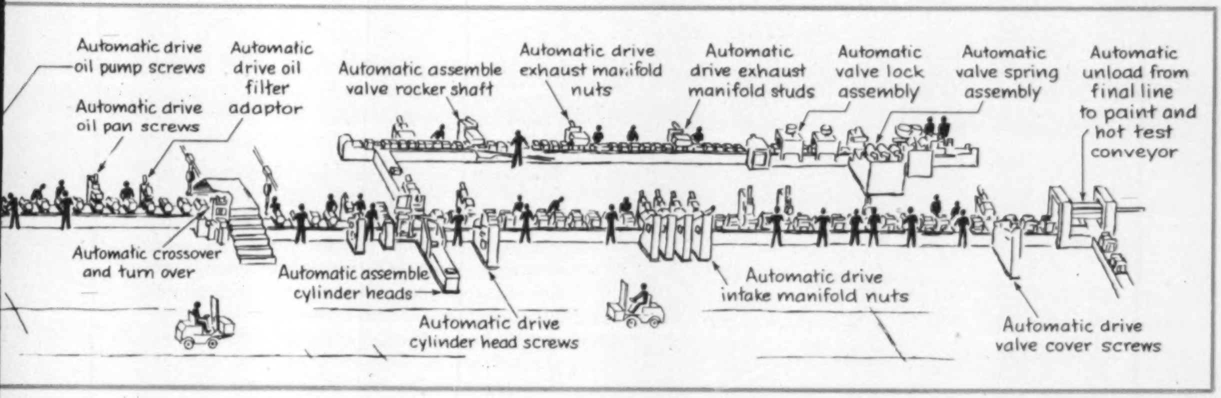
OUR NEW Plymouth Engine Plant in Detroit has been called the most highly advanced productive facility in the automotive industry. Some have gone so far as to call this new plant a pushbutton factory. This is incorrect.

In theory, at least, a pushbutton factory is one that requires only a few operators sitting at control panels. As you will see, the Plymouth Engine Plant is far from being this kind of facility. Its normal working force is about 3000. In building a product as complex as an automobile engine, there are many operations which can be done more efficiently and more economically by making full use of the human brain, hand and eye—and no manufacturer in his right mind is going to automate for the sake of automation. The basic economic decisions that helped determine which processes to automate and which not to automate will be outlined generally.

A plant like this always begins with a need. In 1954 we were tooling up to produce our 1955 "Forward Look" models and at Plymouth Div., we were planning big things for the new cars. In addition to their new styling, they would have V-8 engines for the first time. We knew, however, that our capacity for producing the newly designed Plymouth V-8 engine was far less than we would need. As it turned out, in our first year we were never able to supply more than three V-8 engines out of every ten cars produced.

We needed a new plant for V-8 engines that would come into production in time to power a large proportion of the 1956 model cars, and we wanted that plant to turn out at least 150 engines an hour. We were shooting for more than capacity, however. We also wanted the kind of plant that would lower our costs of production. In the automobile business the competitive drive for lower production costs is just as hot and continuous as the drive for sales. We believed that the best way to reduce costs in our engine plant would be to build the highest possible precision into the machinery and to equip the plant with automatic machine controls that would reduce to a minimum the possibility of error. The result would be reduced expenses for trouble shooting, maintenance and repair, reduced downtime for machines, and minimum loss from scrappage.

Mr. Bentley is now plant manager of the Chrysler Corp. Engine Div. plant at Trenton, Mich.


Automatic drive oil pump screws
Automatic drive oil filter adaptor
Automatic drive oil pan screws
Automatic assemble valve rocker shaft
Automatic drive exhaust manifold nuts
Automatic drive exhaust manifold studs
Automatic valve lock assembly
Automatic valve spring assembly
Automatic unload from final line to paint and hot test conveyor
Automatic crossover and turn over
Automatic assemble cylinder heads
Automatic drive cylinder head screws
Automatic drive intake manifold nuts
Automatic drive valve cover screws

Courtesy, Cross Co.

▸ Considerations and Principles

High quality and low costs became the ruling considerations in designing and building this plant. And now that the plant is producing, we are finding that it has justified the time, effort and resources invested in it. We call it the "Qualimatic V-8 Engine Plant", and it is fully living up to its name. The plant contains far more than an average amount of automatic machinery. It is generally recognized as the most highly automated engine manufacturing facility in the automobile industry. As we all know, automation is a much misunderstood word with varying definitions. On the basis of what we have learned about automation at the Plymouth Engine Plant, automation might well be defined as *the optimum use of machines to produce high-volume, high-quality products at the lowest possible cost*. That definition is, in a way, a description of the kind of plant we wanted to build, and the kind of plant we now have. To build the plant we worked according to two simple, but I think very meaningful, principles.

1. *The first guiding principle was to use machines only where they would bring a clear advantage in cost and quality over the use of conventional techniques.* In theory, of course, you could design automatic machinery to perform virtually all of the jobs done in the engine plant, or for that matter, in an automobile assembly plant. In other words, a pushbutton engine plant is hypothetically possible. In my opinion, however, such a plant will *never* be designed or built. For one thing, it would not be economically feasible to build automatic equipment to perform work that can be done more

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Lights on this panel are part of a system keeping watch on the machines at Chrysler Corp.'s Mound Road engine plant in Detroit. Cylinder heads for Plymouth V-8 engines pass through these machines, stopping momentarily while holes are drilled. An operator on a bridge over the machines watches the control panel which will alert him instantly if there is a failure. The buttons enable the operator to reroute production while maintenance men make any necessary repairs.

2

The word "qualimatic" was originated to describe the highly automated Mound Road engine plant. Instrument in this picture demonstrates why the words quality and automatic were chosen. Representative of the many quality check stations throughout the plant, this is an automatic inspection station for air-gaging cylinder bores. Compressed air is used to check the size of each cylinder to see that correct dimensions were maintained when they were bored.

economically by people. And under modern conditions, with products changing so rapidly, it would be bad policy to invest heavily in equipment designed for building this year's product, if the equipment might have to be scrapped or basically redesigned next year. For another thing, there are many jobs in a plant of this kind which can be done better by skilled workmen than by machines.

It would be difficult to imagine, for instance, the kind of machine that could be substituted for the inspector on the engine test line who listens to the running engine to make sure it has that unmistakable sound of a well-made and well-tuned V-8. There are many other jobs in the plant—quite apart from the hundreds of maintenance and repair jobs—which we would rather entrust to people than to machines. Some of the most important of these jobs are on the engine assembly line where, for instance, connecting rods must be put in place carefully to give them the right clearance, and where tappets must be properly adjusted.

On the other hand, there are many operations in this plant which are performed with far greater consistency and greater precision by machines than they could possibly be accomplished by people. In addition to the many broaching, drilling, chamfering and reaming operations which have long been done by heavy automatic machinery in the automobile factory, there are many hundreds of additional operations which can be done more advantageously by automatic machines than by people. Take, for instance, the nut-runners that tighten head bolts hour after hour and day after day to exactly the right torque—or the automatic counters on the tool-control boards which indicate when the wear-out point is approaching.

In another part of our plant we load parts trays with small components like bolts, nuts and washers by means of automatic hoppers which seldom make a mistake in the number of parts they count out and drop into each tray. In this same section, however, we also employ people to load these trays with odd-shaped parts that would be difficult and costly to handle by automatic processes.

Naturally, it is much easier to put this principle into words than into practice. Deciding when to use machines and when to use manual methods requires the consideration of many factors and the working out of some extremely complex equations. The only way to prove that you have worked out your equation correctly is to put the plant to work and apply the test of practice. I am happy to say that in the months this plant has been operating we have been gratified with the results. Repair on engines has been extremely low, maintenance costs have been at a minimum, scrappage has been drastically reduced, and downtime on the production lines has been lower than ever experienced on any other equipment approaching this in size and complexity.

2. *The second guiding principle was that the design of the product and the design of the plant process should be related to one another as closely as possible to the end that the efficiency of the plant may be raised and the quality of the product improved.* When stated in this way, this principle seems so simple and so reasonable that you would assume all product engineers and all production engineers must have accepted it and used it without question as long as things like automobile engines have been designed and built. The truth is, however, that product design and plant design have traditionally tended to be separate domains. In Detroit it is not unusual, for instance, to hear

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This article is based on a paper presented at the "First Conference on Manufacturing Automation" cosponsored by AUTOMATION and Purdue University, October 1956.

production engineers in the stamping plants complain about the "impossible" things the body designers are asking them to do with sheet metal.

Of course, these impossible things are eventually accomplished by drawing upon ingenuity and upon the endless possibilities of modern machine technology. Moreover, no body designer could afford to work in ignorance of the capacities of the most advanced stamping facilities. He is pretty sure when he drafts his design for a new automobile that it is capable of being mass produced, and his designs are brought to the attention of the production people for clearance as early as possible. But all things are matters of degree. In my opinion there is a much higher degree of communication today between product designers and plant designers than ever before. What happened in designing the engine plant to build a specific kind of V-8 engine is a beautiful case in point.

When it was decided to build this plant we did more than establish an open line of communication between the engineers who were designing the plant and the engineers who were designing the engine. We literally made them live together. The two men with the chief responsibility for deciding on the sequence of operations and the kind of equipment to be used in the plant established temporary offices in the central engineering laboratories so that they could see and talk personally with the product engineers at all times. When they decided that the engines would have to have lugs of a certain kind to be palletized for the assembly line, they asked the engineers if there was any technical difficulty in providing the lugs. When they decided that the pistons would need to be redesigned in order to roll properly in troughs, they explained their need and the product engineers redesigned the pistons. Similar changes were made on dozens of parts of the engine to provide for automatic locating or moving. As far as I know, the consultation between product design and production design on this job is the closest ever achieved in our company.

In my opinion, this kind of close consultation will become more and more the accepted procedure in industry. In an age when innovation in the product is such a dynamic force in creating market demand and when mechanical progress in the means of production is moving faster than ever before, it has become absolutely necessary that the men who design new products work side by side with the men who design the machines to make those products.

▶ Establishing Quality Control

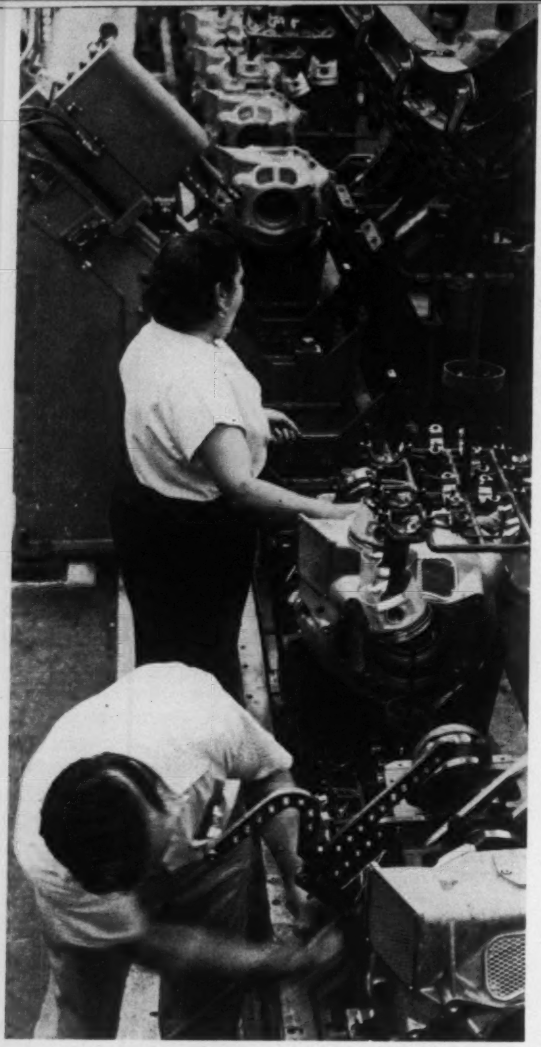
The greatest single problem in controlling the quality of engine manufacture is the difficulty of holding close-to-perfect alignment between various cutting operations on a machined part. In the past. most of the trouble has been caused by the fact that each cutting operation was performed separately, with the part then being passed on to the next station. When a number of holes are bored, drilled, or reamed in a workpiece at more than one station, the holes must be held in perfect alignment with each other. But under these conditions it is difficult to avoid inaccuracies because clamping is never exactly the same from station to station.

These difficulties have been largely overcome in the new engine plant by increasing the number of operations performed on each machine. For instance, on the cylinder block line, one four-way boring machine finish bores the main bearings, camshaft bushings, distributor shaft hole, the oil pump shaft holes, and the dowel holes at the end of the block while at the same time it mills the oil pump pad. Since these six operations are being performed simultaneously on one machine, the relation of each dimension to all the others is held very accurately.

The practice of performing multiple operations on as few machines as possible is not new, of course. Throughout the industry, fewer and fewer machines are required for more and more operations each year. For example, it was not long ago

3

Machines take over the tedium at the engine plant. This equipment is the first automatic assembly machine for connecting rods in the automotive industry. It takes two parts, the cap and the rod, and fastens them together securely with two bolts and two nuts. Machine operator also keeps nut and bolt bins filled.



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When Chrysler Corp. decided to retool for production of V-8 engines for Plymouth automobiles, each operation involved in producing engines was carefully evaluated. The question was asked: "How can this be done most efficiently?" In many cases the answer was with automatic machinery. However, here is an example of an operation that can be accomplished more efficiently by hand. These workers are manually installing piston and connecting rod assemblies into the engine and securing them with caps and bolts. Farther along the line, automatic machinery tightens the bolts.

that as many as 12 milling machines were required to work the flat surfaces of engine blocks at the rate of 110 an hour. Today, two broaches machine those surfaces at the rate of 140 an hour.

Some of the most interesting features of the plant are those having to do with testing the pieces as they are being worked. This testing process begins back at the foundry. Castings for the head and block lines of the finest quality attainable are produced by controlling quality throughout the entire casting process. The castings are also produced with extremely close limits on the stock to be removed in the machining process. Before any casting is allowed to go into the machining lines it must first pass through a qualifying machine. Any castings that exceed the specified dimensional limits are rejected immediately.

In making the decision to use broaches rather than milling machines for the flat mating surfaces of the cylinder block and head, we had to make sure we could control the quality of the casting both as to its dimensions and the consistent hardness of the metal. While broaching gives a greater production of parts per hour than milling, in comparable machine investment, in the past one of the principal sources of downtime for broaches was tool breakage as the result of occasional "hard spots" in low-quality castings.

Throughout the plant there are automatic testing devices to make sure a piece has been properly worked. Following every drilling operation in the head and block lines, for instance, there are automatic probing stations equipped with feeler gages to insure that holes have been machined to the right depth and that they are free of broken tools. If no hole exists where there should be a hole, the machine is stopped automatically at that point until the cause of the defect is rectified.

After many of the machining operations we use air gages to check dimensions. If tolerances are exceeded, the machine operators are informed immediately by means of colored lights at their control panels. At the same time, one of three lights on the machine goes on automatically and informs tool men in the working area of the trouble so that it can be remedied in a matter of seconds. At many points there are gages which indicate, also by means of colored lights, that holes are approaching the "out-of-tolerance" range.

▶ Automation and Personnel

It is interesting to note the effect of this automated plant on the people who work in it. Without distorting the actual situation in any way, it is apparent that the people working in this new plant have a considerable sense of pride in their plant. Every day they see many visitors pass their work stations, visitors who have heard about the plant and who are intensely interested in what they see open house. In the second place, many of the people in the plant have far better jobs today than they once had, with higher ratings and higher pay. This is true because the proportion of maintenance workers, such as electric repairmen, millwrights, and tool setters, is much higher in a plant of this kind than in one that is less advanced. Beyond these advantages, the people who work in this kind of plant know that their working hours are safer, less fatiguing, less monotonous, more productive, and more interesting than they would be in a plant with less automation.

We are often asked what effect this new plant has upon employment. Early in 1956, in an attempt to give a good answer to this question, we took a representative working day, January 15, and made a count of the number of people at work in the company on the production of Plymouth engines, both V-8's and sixes. This was then compared with the number of people producing engines on the same day of the two previous years, before the new engine plant was in operation. Here are the facts: On January 15, 1956, 6533 workers were employed in building Plymouth engines of all types. On January 15, 1955 the number was 5322. On January 15, 1954 the number was 4297.

Now I want to be the first to say that the importance of comparisons of this kind should not be exaggerated. It is difficult to account for all the factors so as to make any given day strictly comparable to the same day in other years. Nevertheless, the figures do show there has not been the sudden drop in employment, or the displacement of workers, that many people expect to result from the building of a plant of this kind.

It is true, of course, that people are switching to different kinds of work in the plant or in the company. And the company is helping them to prepare for the new opportunities and responsibilities that open up as the result of these new kinds of equipment. Classes are now being offered, for instance, in electronics and industrial hydraulics for journeyman electricians and machine repair men who completed their apprenticeships before these fields were included in their studies about seven years ago. Today, 154 employees have completed a two-hour-per-day, 24-week training course in industrial hydraulics, and an additional 178 employees are now enrolled in the course. A similar 48-week course has just graduated its first class in electronics. All courses of instruction are held on company time, during an employee's regular working hours.

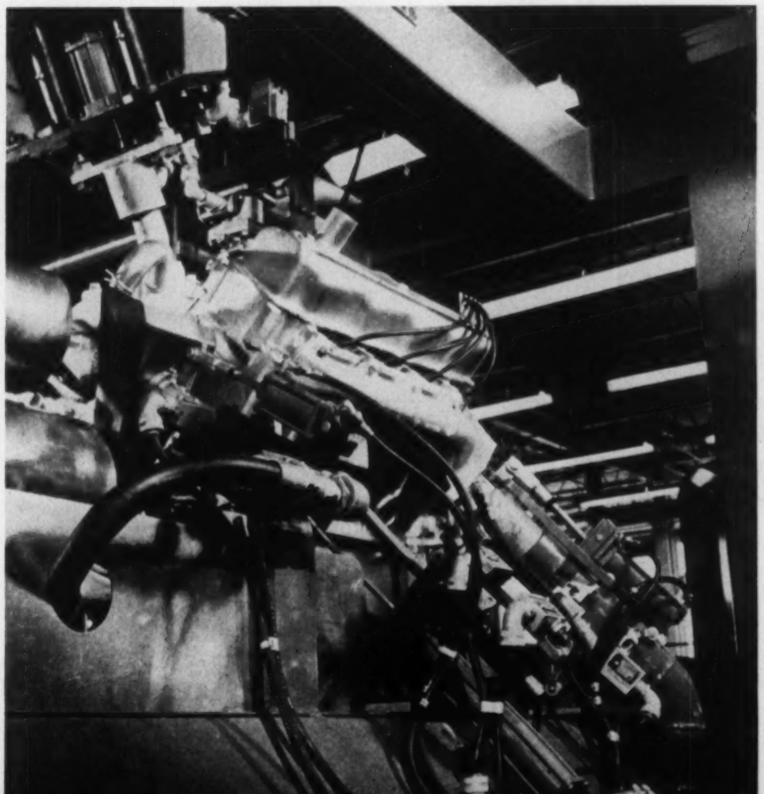
▶ Automation and the Economy

Speaking generally about automation, it appears to offer three tremendous advantages to the economy. First—automation is coming along at a time when the total population of this country is increasing much faster than the number of people available for productive work. It has been estimated, for instance, that in the next ten years the population will increase by 20 per cent and the portion of the population available for work by only 6 per cent. In this situation, with proportionately fewer hands to do a lot more work, automation is going to be a very timely blessing indeed.

Second—by increasing our efficiency in the volume production of goods and services, automation will help control the pressure toward inflation which is nearly always present in a dynamically expanding economy like ours.

Third—like every other advance in efficient production, automation will raise quality, lower costs and widen markets. And this will put steam into the forward drive of the whole economy.

This is the broad view. The closer view of the application of automation at the Plymouth Engine Plant has shown its advantages in producing higher quality products in volume. Certainly the Plymouth Div. and Chrysler Corp. as a whole will continue to build the most modern plants possible to achieve more of these advantages.



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Each completed engine receives a run-in test under its own power in the "hot test" area of the plant. Here, fittings are attached automatically, and the new V-8 power plants are supplied with oil, water, fuel and electricity. After successfully completing its test cycle, the engine receives a final inspection and is ready for shipment to the car assembly plant.

AUTOMATING BATCH HEAT PROCESSES

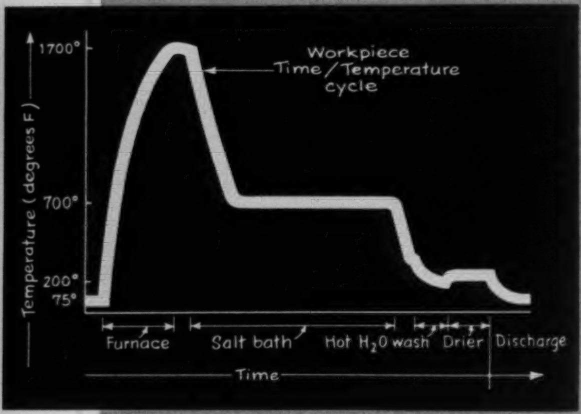

Fig. 1—Time-temperature cycle for an industrial heat process. Workpiece is a small steel part; process is known as Austempering. Critical values are high temperature, fast cool to 700F, and hold at 700F for predetermined period of time.

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Studies of the overall economics of automating a given processing cycle often indicate that automatically controlled batch type production makes the most efficient use of manpower, energy and space. Applications that illustrate this automation technique are documented here.

VIRTUALLY EVERY PRODUCT of industry is, at some point of its manufacture, subjected to heat to produce certain physical characteristics, or to effect a chemical change. In many fields, the heat treatment is a continuous process under fully automatic control. At the other extreme, some products, such as varnishes, are placed over the heat source and kept there until an operator is satisfied that the correct condition has been achieved: in a similar way, the housewife will put a pot of soup over a burner on the range, and let it cook until she is satisfied that the ingredients are thoroughly cooked and the flavors have blended.

Although such a batch process cannot be considered fully automated, since it lacks the automatic mechanical handling of the workpiece or product, there are batch heating applications which can be placed at a high level of automation as far as precise automatic control is concerned, and they will benefit from more accurate processing and more economical operation. This applies to batch heating of solids, and to heat processing of a single workpiece, as well as to the processing of fluids.

Basically, heat processing consists of subjecting a product to a controlled change in temperature to achieve desired characteristics. In some cases, the end temperature is the only criterion used. However, in more advanced technology the whole time-temperature relationship is important, and tests of various time-temperature cycles on a variety of workpieces have resulted in notable process improvements. The curve in *Fig.* 1 illustrates a heat process viewed from this standpoint.

▶ Process Criteria

If it is to fit into increasingly automated manufacturing, the heat processing equipment must conform to the same overall considerations which govern other segments of the automated production line.

One of the most significant aspects of automating any part of a process is that the quality of the workpiece must be controlled more carefully than has hitherto been necessary. One might say that the machine itself detects differences that the human operator of earlier machines could compensate for—and therefore could overlook. The automatic machine must also be fed its raw materials at a rate which will justify its use. One may list, therefore, as criteria for any process which is used with an automated process, the incorporation of quality and operating controls and materials handling equipment to match the performance of the associated processes.

The high capital cost of the modern plant, resulting, in part at least, from the use of automated and mechanized equipment, demands that manpower, space, energy and materials be used in the most efficient manner possible. This becomes a consideration for processing equipment whether it is itself automated or whether it is nonautomated equipment used in connection with other automated equipment.

Designers have found that the addition of controls to conventional machinery has not been entirely successful. It is necessary, rather, to go back to the workpiece or product itself, and study the manufacturing process in relation to the product, and then to design equipment to fit the workpiece requirements in terms of the process.

All these considerations must be followed in the heat-treating equipment which is associated with automatic or semiautomatic production. The high production rates, for instance, which make the automated processes practical, call for short heating cycles and these in turn for high heat transfer rates. This means a large release of energy per unit area of floor space, and a more efficient use of fuels. These latter considerations are a restatement of the need for efficient use of manpower, space, energy and materials. Most important, perhaps, is the fact that automatic equipment can detect very slight differences in workpiece characteristics. In terms of heat processing, this means that the optimum time-temperature cycle must be determined, and this cycle consistently reproduced with close accuracy.

▶ Annealing Operation

The considerations suggested in the preceding paragraphs can be met by heat processing equipment, even though this equipment does not employ mechanized loading and unloading.

The furnace in *Fig.* 2, for example, is a unit which is fed and discharged manually, heating one workpiece at a time, and yet provides the control, efficiency and high production rates characteristic of automation.

This furnace illustrates the importance of stating specifications in terms of end results, rather than conventional—and possibly obsolete—practices. The production situation called for annealing a stainless steel cone as an intermediate step in forming the body of a color television picture tube. The rate required is one cone every 2 minutes. The manufacturer believed that a furnace 85 feet long was necessary to meet this production. Selas engineers, however, studied the process it-

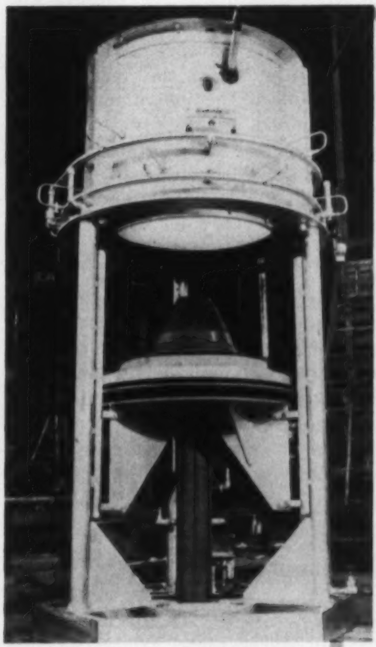
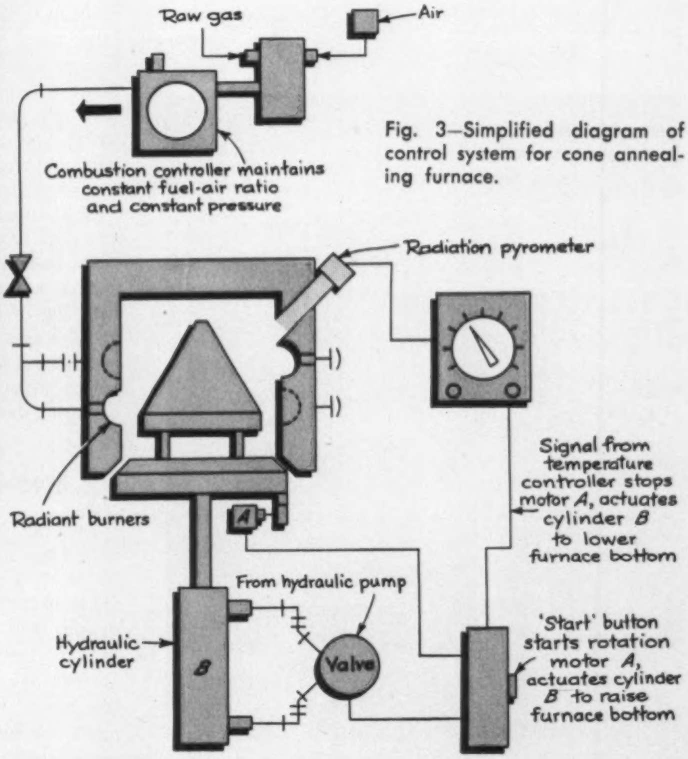


Fig. 2—Annealing a spun stainless steel cone under automatic temperature control.



Raw gas
Air
Combustion controller maintains constant fuel-air ratio and constant pressure
Radiation pyrometer
Radiant burners
A
Signal from temperature controller stops motor A, actuates cylinder B to lower furnace bottom
From hydraulic pump
Hydraulic cylinder
B
Valve
'Start' button starts rotation motor A, actuates cylinder B to raise furnace bottom

Fig. 3—Simplified diagram of control system for cone annealing furnace.

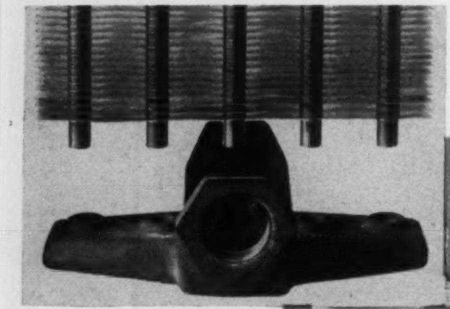


Fig. 4—Copper tubing with aluminum fins is brazed to cast iron headers to form room heater.

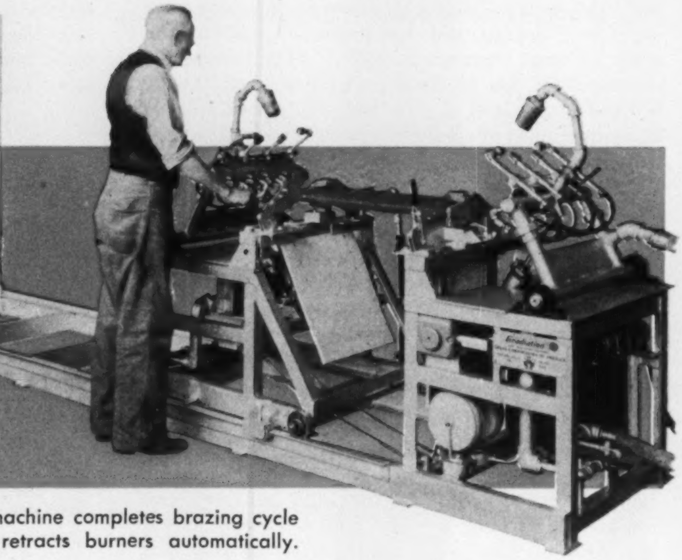


Fig. 5—Once loaded, machine completes brazing cycle on room heater and retracts burners automatically.

self, and developed a much smaller furnace to meet all the requirements. The unit shown actually occupies only 4½ by 4½ feet of floor space and is 10½ feet high. It raises the temperature of each cone to 1550F and allows the workpiece to cool slowly at room temperature. The production is the required 30 cones per hour.

The simple control system of this batch heating unit, *Fig.* 3, assures reproducible uniformity within each succeeding workpiece. One cone is loaded at a time, and the cycle started by pushing a button. The hearth rises to form the bottom of the furnace. A radiation pyrometer, focused on the cone, signals to a controller when the desired temperature is reached. The controller actuates the lowering of the hearth to the charge-discharge position.

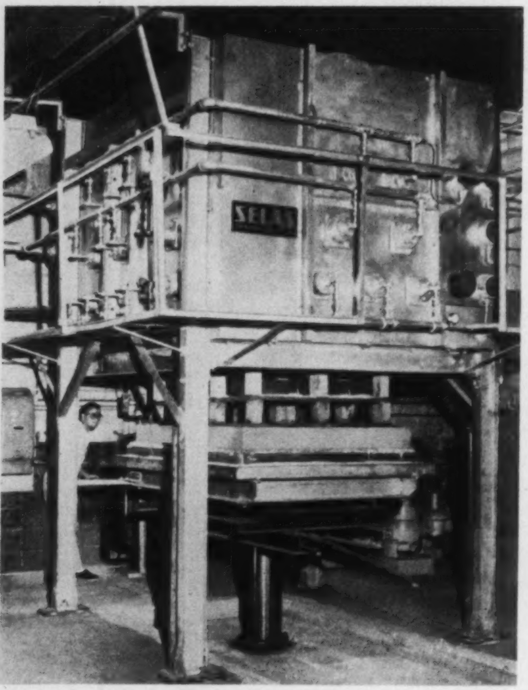


Fig. 6—Elevator kiln fires large diameter grinding wheels under automatic temperature control.

This installation poses a problem common to the use of temperature-sensing control systems. The radiation pyrometer is measurably affected by radiation originating in the burners and reflected from the metal surface on which the pyrometer is focused. The set point of the instrument, therefore, must be determined empirically to produce the process temperature in the workpiece; the set point will actually be considerably above the temperature desired. With combustion and furnace conditions stabilized, however, consistent metallurgical characteristics are produced with this simple feedback circuit.

Controlled combustion of accurately premixed gas and air in radiant ceramic-lined burners provides fast, efficient heating. The accurate patterning of a large number of small burners and the rotation of the workpiece assure a uniform anneal at all parts of the cone. Cones not uniformly annealed will fail during the succeeding forming steps which must take place to complete the television picture tube.

▶ Brazed Automatically

Brazing is another field where one workpiece at a time may be processed under such control as to meet the requirements of automation. A difficult brazing problem is represented by the photograph, *Fig.* 4, which shows an iron header that is to be brazed to copper tubes with aluminum fins to form a room air heating convector. In this case, the heavy iron casting and the thin-walled tubes must be brought to brazing temperature at the same time, without heating the aluminum to its melting point.

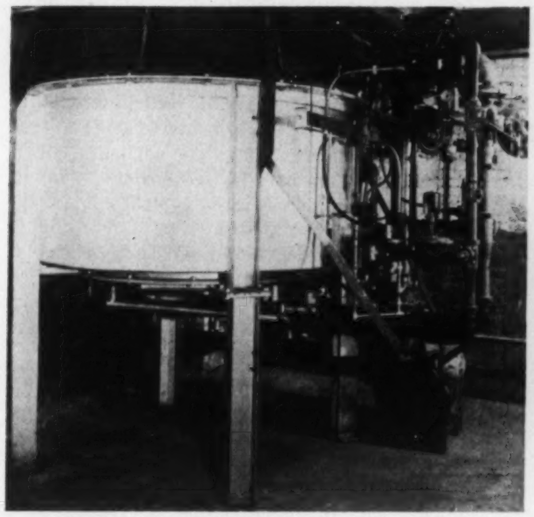


Fig. 7—Combustion system and burner-setting for batch heating of fluids. Kettle extends through ceiling, so that fuel combustion areas are completely separated from inflammable substances being processed.

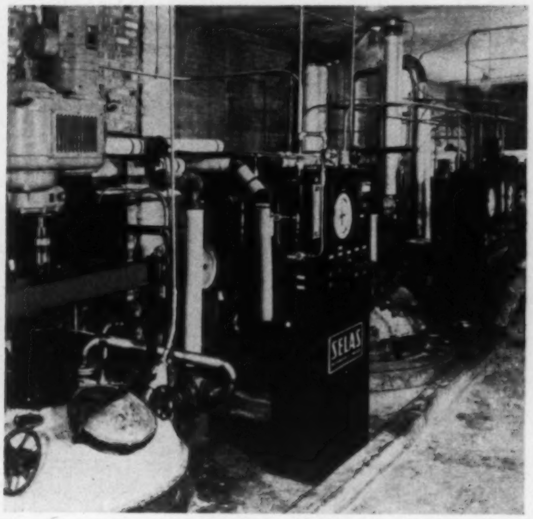


Fig. 8—Kettle-top and piping of batch fluid heating system shown in *Fig.* 7.

The temperature at which brazing takes place is accurately controlled on a machine, *Fig.* 5, by eliminating variables in the operation. Accurately premixed and pressurized gas is fed to the burners at a known rate, and the heat portion of the cycle is limited by an electric timer. The operator assembles the unit, and loads it into the machine. When he pushes a button, both headers for each convector are properly brazed and the burners are automatically retracted.

These two examples of heating workpieces individually could be made fully automatic by the addition of charging and discharging equipment. There are, however, batch heating processes which are further removed from mechanical handling but which are also automated in the sense of the production rate, efficiency and close control.

▶ Ceramic Firing

One of the oldest industrial applications of a time-temperature cycle is in the firing of ceramics. In its most primitive form this consists of setting mud shapes in the sun for an indefinite period to harden. In modern industry, however, the shape, constitution and desired end product characteristics determine the exact time-temperature cycle which must be followed for optimum results.

In *Fig.* 6 a load of alumina grinding wheels up to 20 inches in diameter are being lowered from a kiln. In this kiln, the wheels must be slowly raised to a temperature of 2240F and held there for a carefully predetermined time, and then allowed to cool slowly. This constitutes a time-temperature cycle of many hours.

Because of the nature of the workpiece in this case, higher speed cannot be obtained. However,

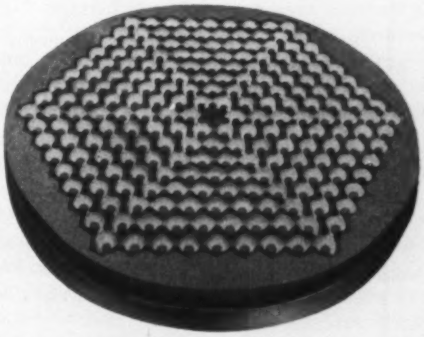


Fig. 9—Cluster of small gas-fired radiant burners provides fast heating, extreme turn-down range and close temperature control.

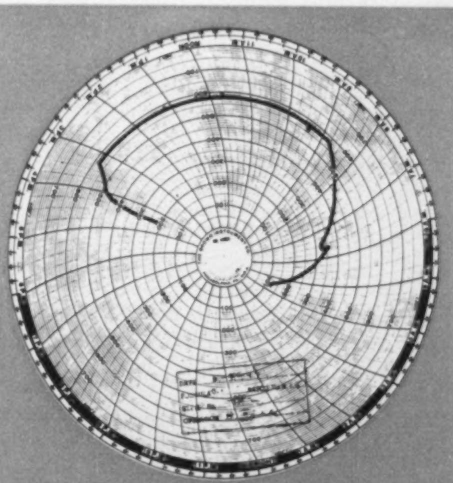


Fig. 10—Typical heating cycle record of batch fluid heating under automatic control.

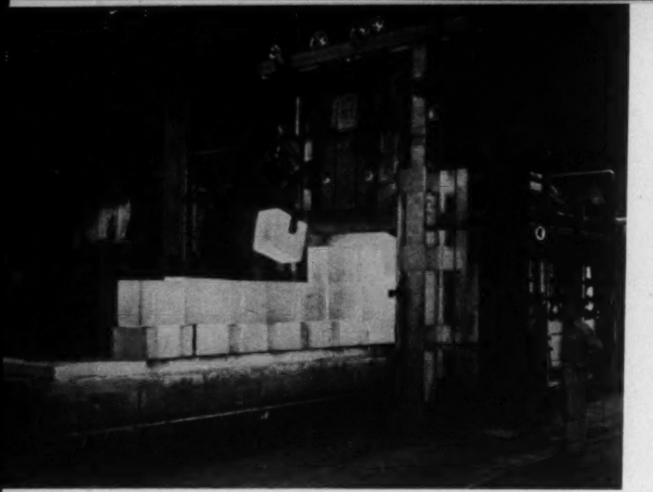


Fig. 11—Designed to meet exact workpiece requirements, this furnace heats die blocks five times faster than conventional furnaces, with 20 per cent less fuel consumption per pound of steel processed.

the accurate temperature at every point in the cycle is important. For this reason thermocouples in the furnace area are used to determine furnace temperature, which rises so slowly that the workpiece temperature is seldom more than a few degrees lower. The actual temperature during the heating-up period is registered on an indicating controller.

▶ Heating of Fluids

A batch heating process closer to the soup-heating analogy used earlier is illustrated in *Figs.* 7 and 8, which show the burner-setting and kettle in which varnishes are bodied. Gums, resins, or synthetics are introduced cold to the kettle with suitable solvents. The charge is heated to a specified temperature—usually in the range between 300F and 500F—and held at that temperature for several hours. The characteristics of the paint will be determined by the temperature at which the vehicle is bodied, and the length of time it is held at that temperature.

While the high temperature portion of the heat process cycle is thus fixed, economical utilization of equipment and overall increase in production can still be obtained by faster heat-up. On the other hand, localized overheating—"hot spots"—will discolor and otherwise decrease the value of the product, and will also adversely affect kettle life.

All these factors point to the use of the "Duradiant Cluster" hearth shown in *Fig.* 9. The burners are manifolded so that three fuel feed lines are used, each zone including one or more rings of burners. The cluster may be set as close as 10 inches from the kettle bottom without localized overheating, since combustion is confined to the burner cup, and only radiant heat and combustion products reach the kettle. Direct firing at close proximity produces fast heating through efficient heat transfer.

Control is progressive. The cluster fires at full fuel pressure until the reaction temperature is approached. As the temperature increases, the larger, outer manifold is proportionately closed until it is completely shut off. As the temperature continues to rise, the middle and inner manifolds are throttled in turn. An overriding control is usually provided to turn off the pilot burner when temperature rises a few degrees above the set point, since some of the reactions may be exothermic. *Fig.* 10 shows the controller chart of a typical cycle: 600 gallons of alkyd resins heated from 100F to 580F in 4 hours 40 minutes, and held at 580F for 6 hours 30 minutes.

The temperature sensing device is usually a submerged thermocouple, which is accurate and practical for measuring the temperature of fluids.

Similar settings are used with kettles or reactors for a number of chemicals. The operation in these cases is quite similar, although controlled temperature rise may be employed, and the batch can be held at two or more different temperatures in succession. Controlled heat input is possible during the cooling period if necessary.

▶ Hardening Die Blocks

Another process which is deceptively similar to conventional practice is shown in *Fig.* 11. This is a car-bottom furnace which heats 20-ton loads of alloy steel die blocks. It is one of a firm's 13 furnaces of approximately the same size and shape which harden blocks from 8 to 24 inches thick. But while the other furnaces require 20 to 30 hours for a full cycle, application of a completely automatic program controlled heating method to the new furnace has resulted in reduced heating cycles of only 3 to 4 hours to produce the same results.

Metallurgists have long considered that the only safe way to process such large sections of high alloy steel is to heat at a rate of 100F to 150F per hour, and soak at temperature about one-half hour per inch of average cross section. It was

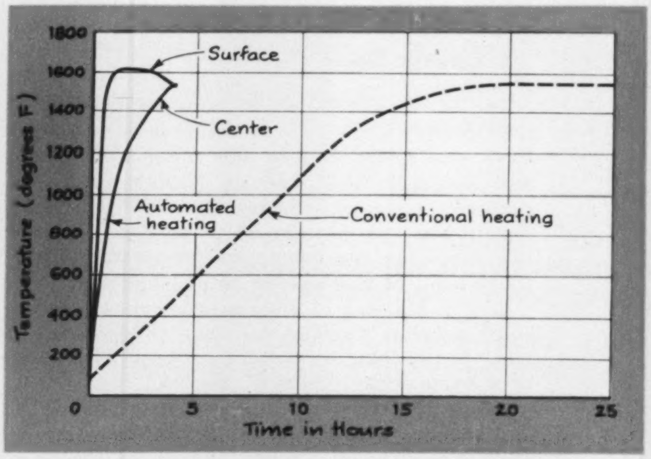


Fig. 12—Comparison of heating times of large die blocks for hardening by conventional and by automated process.

felt that heating beyond the quenching temperature (in this case 1550F) would result in cracking of expensive dies. Analysis of the problem in the Selas laboratories, however, showed that with properly patterned gas-fired radiant burners, the surface of the block could be raised safely to the limiting temperature in only 45 minutes; under these conditions, however, it still took 4¾ hours for the center of a large block to come to 1550F. The heating rate was therefore increased so that the surface was quickly brought to 1650F. Under the new program, the total cycle was an hour less: only 3¾ hours.

Fig. 12 illustrates the new heating cycle in relation to the old. The old cycle was established by placing the workpieces in a furnace at the desired end temperature. The new cycle is the result of Gradiation heating: a high temperature gradient is established between the furnace and the workpiece, producing faster and more efficient heat transfer. Close temperature control is exercised by interrupting the heat-up portion of the cycle while the temperature is on the rise, eliminating costly soaking periods.

The program shown in *Fig.* 12 is suitable for a work load ranging from 8 to 24 inches in thickness. In order to accommodate the various thicknesses, a cam-controlled programming system was decided upon. For any thickness, an optimum heating curve can quickly be obtained, and cut into a cam such as shown in *Fig.* 13. This cam then provides a varying set point for the controller shown in *Fig.* 14 (at top left) which regulates the fuel mixture flow to correct any deviation of block surface temperature from the desired amount. The controller at bottom left in the same photograph provides protection against overheating the furnace itself.

The vice president-manufacturing of the plant in which this die block heating furnace is installed has listed its benefits, providing a check list of advantages which may be expected from the automation of any batch heat process. He points out that:

1. Fuel consumption per pound of steel treated has been reduced 20 per cent.
2. Overall plant efficiency is improved because a close production schedule can be maintained.
3. Less-skilled personnel can handle the heating operation.
4. Minimum attention is required (only about 20 minutes of operator's time is needed over the entire 3¾ hour cycle).

In addition to these advantages, a considerable saving in capital investment was achieved. This company was considering erecting a new heat-treating building to add additional furnace capacity. Now, as increased production is needed, the conventional furnaces will be replaced by the automated, program controlled short-cycle furnaces. When conversion is complete, this heat-treating department will have multiplied production by five times in the same floor space with the same number of furnaces.

▶ Important Approach

While this article has documented the application of automation to batch heat processes, it should be noted that the use of batch processing instead of continuous processing or mechanized transfer between work-stations is in reality only incidental. Far more important in every case is the examination of the workpiece, re-evaluation of the processing required, development of an optimum work cycle, and the application of fast, controllable heating methods to produce this cycle. These steps have resulted in more economical heat processing co-ordinated with associated production steps, and higher and more uniform product quality, with appreciable economy of manpower, energy and space.

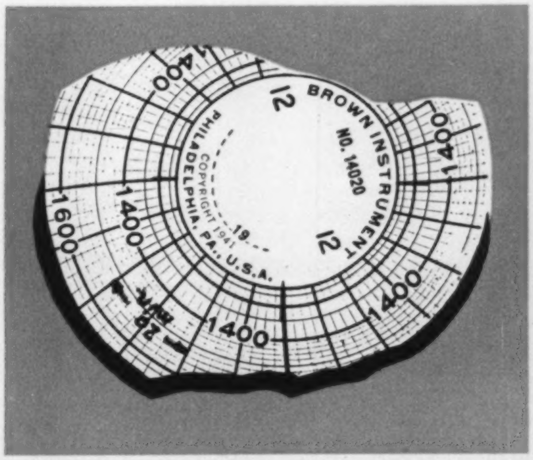


Fig. 13—Program control used for directing the heating cycle of 12-inch thick alloy steel die blocks.

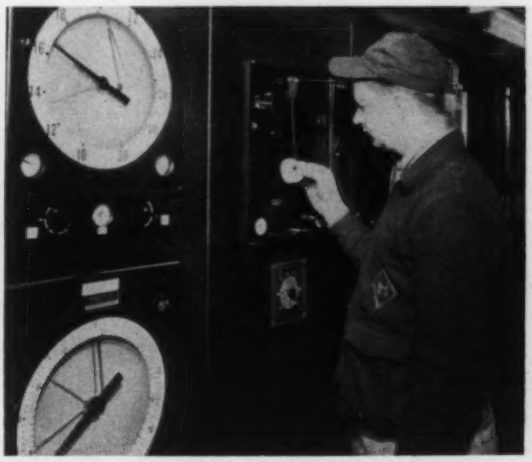


Fig. 14—Furnace operator inserts programming cam at furnace control center.

STRIPPING COIL LEADS MECHANICALLY

WIRE STRIPPING is a unique example of how progress in one area creates problems in another. Factors which make modern insulations so effective also make it difficult to remove insulations without damaging the underlying conductors. Impregnated cloth, fiber glass, plastics, rubber, enamel and similar films are examples of the types of insulations in use. In obtaining reliable electrical connections during many manufacturing operations, these insulating materials must first be removed from a wire—and removed completely. This seemingly simple problem can be of major proportions depending on such factors as the quantity of production and the size of wire requiring stripping.

Various means are used in industry to strip wire: Hand sanding, chemical stripping, burning, solder dipping and wire stripping machines are typical means. In this age of electronics, stripping of wire in large production quantities can be part of a production operation involving trimming to length, fluxing and tinning prior to an actual connection operation. Of the available means considered from this standpoint, mechanized wire stripping lends itself to a continuous line type of production setup. An example is an installation of a coil lead trimmer and insulation stripper designed for, and in co-operation with, the Raleigh Motor Plant of the Westinghouse Electric Corp. by Rush Wire Stripper Div., the Eraser Co. Inc.

As shown in the illustrations, the coil is placed in a pocket of a chain conveyor with lead wires extended. The extended leads are cut to required lengths by a set of clippers. Coils continue on the conveyor and the extended lead wires pass between the rotating stripping wheels of two twin-headed wire stripping machines, one located on each side of the conveyor. Each lead wire is stripped twice to insure complete removal of all insulation. The stripping machine on one side of the conveyor is positioned on an angle to bring stripping wheels closer to the coil body. After the insulation has been stripped off, the chain conveyor deposits the coil on a belt conveyor to convey it to the next operation. Residue from the stripping operation is drawn into a dust collector located below the conveyor. The detailed photograph shows the two heads of one stripping machine. The wheels are composed of strips of "glass cloth" and when rotated at high speeds soften the insulation by friction and wipe it off without abrading the wire.

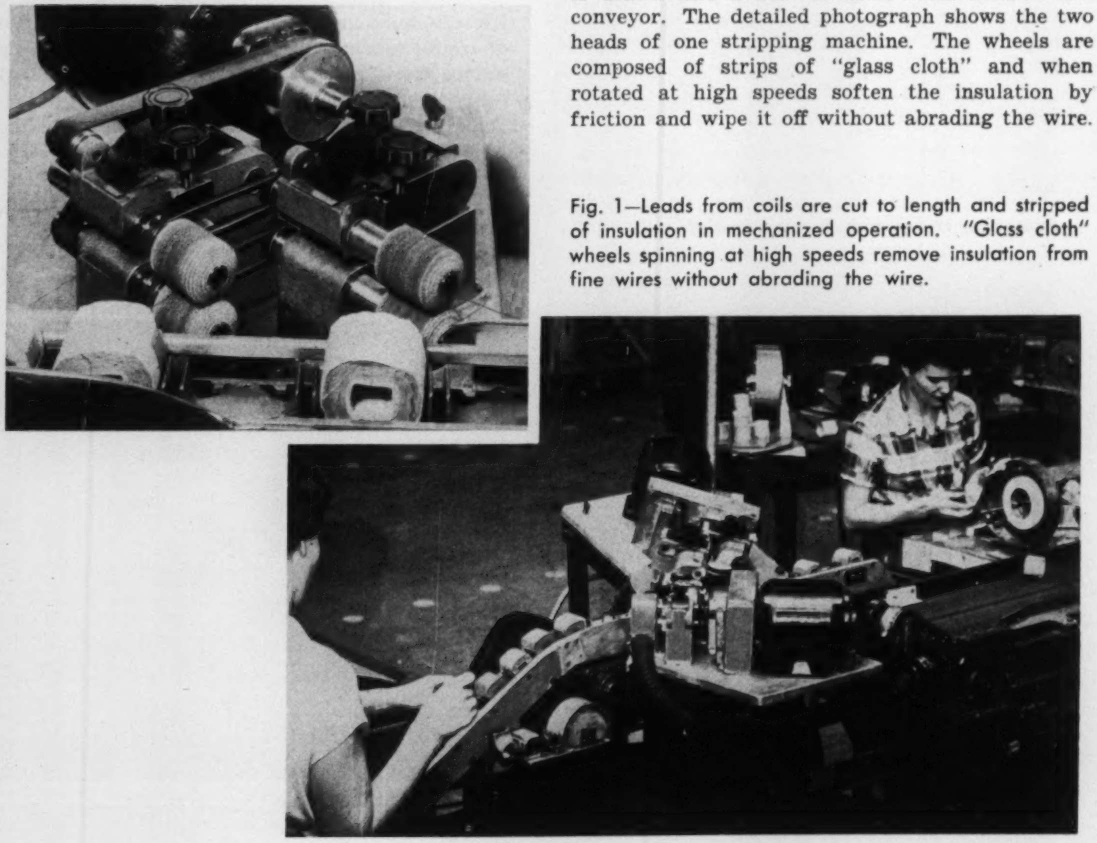


Fig. 1—Leads from coils are cut to length and stripped of insulation in mechanized operation. "Glass cloth" wheels spinning at high speeds remove insulation from fine wires without abrading the wire.

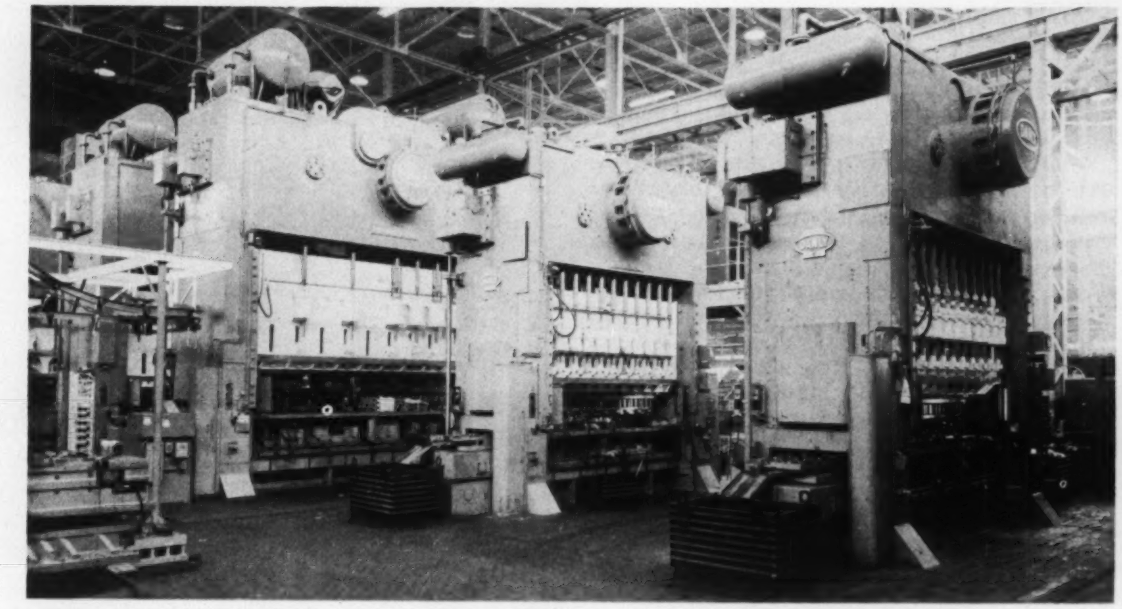


Fig. 1—Four Danly Transfer Feed Presses installed in a major automobile producer's plant. At left is part of an automatic system which is planned to eliminate box handling of parts for all four presses.

PROGRESS IN STAMPING

An illustration from an automotive stamping plant indicates some of the changes which have occurred in pressrooms over two decades. The author also mentions points to be considered in design of automatic equipment.

By **W. D. BERRY**

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MENTION OF MODERN FACILITIES for stamping and fabricating of sheet metal parts brings to mind, today, automatic material handling devices such as press loaders, unloaders, conveyors, shuttles and things of that sort which move a part into or out of a stamping or welding press, move it automatically from press to press and finally load the finished part onto a stock truck or conveyor. But such equipment was not part of the pressroom scene a few years ago, and further developments are sure to occur.

Stamping Then—and Now

To illustrate how far such facilities have advanced in the past 20 years a "then" and "now" comparison from the automobile industry can be cited. In 1936 one of the automobile companies built a stamping plant which was then the last word in manufacturing efficiency. The plant contained approximately 500,000 square feet of floor space and employed about 1200 people. Though it was the most modern plant in the industry it still made full use of manual labor. The automobile floor pan is a high production item which has remained roughly similar in design and will make a good subject for comparison. This panel when completed forms the floor of an automobile body. It starts out as a flat sheet of body steel, possibly 7 feet long by 5 feet wide, weighing about 50 pounds. After it has been shaped by press operations and reinforced by stiffeners and other braces which are welded to it in the metal assembly depart-

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Based on a paper presented at the conference of the American Society of Tool Engineers, April 1956 at Purdue University ment, it is strong enough to become the foundation on which the body is built.

In that 1936 plant, two large stamping presses were required to perform the forming operations on floor pans. Steel blanks, in a bundle of about 200 sheets, were set on horses in front of the first press. Two men, one on each end of the pile, picked up the top sheet and placed it against the stops in the die. The press was then run through one cycle to draw the panel. As soon as the dies started to separate, two men on the back of the press reached in, pried the panel loose, pulled it out, placed it on a pipe slide and then pushed it to the second press. Two men on the front of the second press lifted the panel from the pipe slide and positioned it in that press. After this press had completed its work cycle, two men on the back of this second press reached into the die, pulled out the panel and placed it on a truck. This second operation trimmed off all excess metal, so all of the four men were assigned specific pieces of scrap which they were to take out of the press and place in a tub before the next panel could be loaded. When 50 panels had been piled on the truck, the line stopped until the filled truck could be pushed out of the way and an empty placed in the loading position.

Generally it was necessary to supply extra lubrication to certain parts of the blank to make it draw successfully. This was accomplished by stationing two additional men at the stockpile in front of the draw press. Each man had a mop and a 5-gallon bucket of drawing compound. Their job was to paint drawing compound on each sheet in a prescribed pattern before the operators put it in the press. The production rate was about 150 pieces per hour. Ten men were required to accomplish this and they earned their wages.

Without going through the various steps in the transition, let's see how this job is done the modern way. It was found that a better panel could be produced if part of the work was taken out of the second die. This line now uses three presses instead of two. In today's modern plant, the pile of sheet blanks is loaded, off line, onto a cart which is mechanically moved into position at an unloader station. This unloader automatically picks off the top sheet and places it in a pusher type press loader. If drawing compound is required, it is applied in measured amounts at this point by ordinary spray heads, properly located.

At the proper time in the press cycle the loader gets a signal and pushes the sheet into the die. The loader will not move unless there is a sheet in position ready for loading. The press unloading device has also received a signal to unload the drawn panel and it has that panel out of the way before the new sheet gets in. The panel just unloaded is placed on a conveying device which moves it into the loading station of the next press. This device is so interlocked that it cannot put a panel into the loading station if that station is already occupied, nor will it permit the first press to operate if there is a panel in its unloading station. The dropping of a panel into the unloading station is the signal for this device to operate.

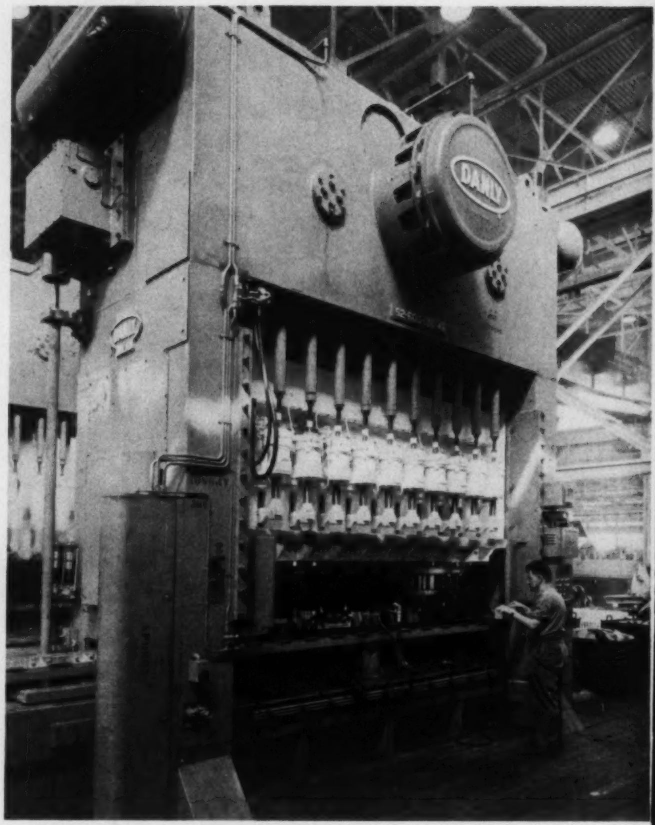


Fig. 2—This 600-ton unit is equipped with 10-stage dies to automatically perform five drawing, one trimming, two coining and two piercing operations on blanks which are automatically fed to the press.

Completion of unloading and loading operations sets up a circuit which starts the press on its next stroke. The second press gives a signal to its loading and unloading devices at the proper point in its stroke and the sequence of events described for the first press takes place here. The third press is loaded and unloaded in a similar manner except that the now completed panel is carried away from the press on a conveyor which loads it onto a truck. It might be interesting to note that the scrap which is produced in the second press is now made to fall free from the die into chutes which carry it to the basement where it is automatically gathered and finally baled.

It can be seen that this line is fully automatic; however, in practice one man is stationed at the start and another at the end of the line. Production rates are high, probably somewhere around 600 per hour. The limiting factor in this case is the speed of the draw press. If this operation were installed in a higher speed unit, the rate could be increased considerably without making any other changes.

Design for Tomorrow

A possible ideal in automatic press lines is exemplified by the Danly Transfer Feed Press. This is a press design in which all of the dies required to make a particular part are mounted in a single press. The dies are mounted side by side in the proper operational order. A mechanically driven transfer mechanism moves the workpiece from one die to the next with each successive stroke of the press.

In operation, a blank is automatically placed on the press loading station. The press makes a work stroke, and as it starts its return stroke the transfer mechanism grasps the blank and all of the other pieces in process and moves them forward one station, where they are located in their new positions in time for the next work stroke. At every stroke of the press, one blank is fed in and one finished piece is ejected. The press is driven by a motor adjustable through a 2 to 1 speed range. The high speed is normally the production speed and the low speed is used for setting up and tryout. Since the transfer device is driven mechanically, it can never get out of time with the slide and complicated interlocking is not required. When on a production run the press operates continuously.

However, application of this method of stamping is limited by the physical size of the press required. For instance, so far no body builder has seen the need for a press that is capable of performing all three floor pan operations with a single stroke. The cost would be very high. An alternate method is what is being applied today; single station presses are being equipped with loaders, unloaders and transfer devices and interlocked into lines.

In the early days of mechanization, the devices produced by the plants were, and in some cases still are, called gadgets. This was not a misnomer. They were strictly cutting torch and arc welder jobs and some were made without benefit of drawings. They were very crude, but they worked and proved that the principles of automatic handling were right. Modern devices must work day after day without trouble. They must be designed and built for this sort of service. Some of the very important things that everyone concerned with design of automated press equipment should consider include: safety, simplicity, ruggedness, reliability, type of drive, portability and proper control.

Safety is a consideration of every designer. In the automatic press line the greatest part of the safety consideration will be guards consisting of screens, rails, gates and so on to keep everyone out of the danger zones while the line is in operation. Any portions of the guards designed to be movable for access to the equipment should be equipped with switches that will stop the line if a guard is removed and keep it from operating until the guard is again in place. Emergency *Stop* buttons should be considered for critical points. Every well run plant is a clean plant and a clean plant is a safe plant. The designer can do his bit here by producing a design for equipment that is well arranged and is easy to keep clean.

Simplicity of mechanical design and of electrical, hydraulic and pneumatic circuits is very important. The simple device is easier and cheaper to build. It will give longer trouble-free operation and is easier to service. Furthermore, if the maintenance men think a device is too complicated to understand, most of them try to keep away from it; consequently the simple device will get the most attention.

In designing automation equipment for a line of presses it is important that portability be considered for various sections so that the area in front and back of a press can be cleared for die change or service. The design of the equipment must therefore not only be rugged enough to maintain precision fits of all moving parts, but also must be rugged enough to withstand lifting and moving with overhead cranes.

Additional Considerations

Automation devices should also be reliable, but this is generally accomplished only when the components used, such as limit switches, relays, air

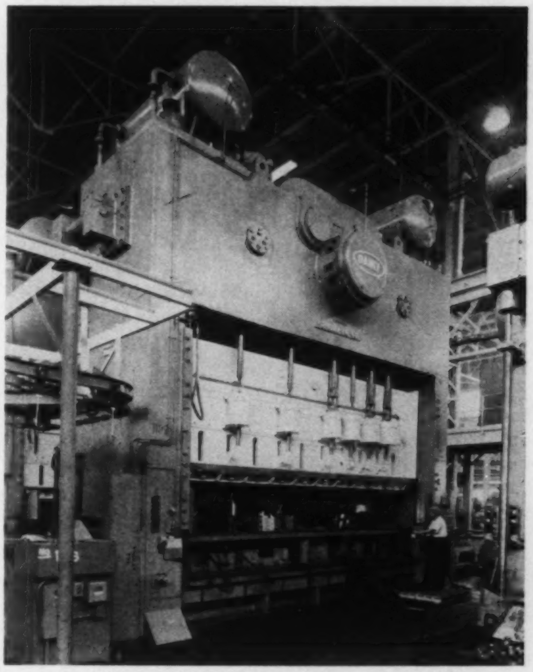


Fig. 3—Single Transfer Feed Press used in stamping automobile chassis parts combines operations of six single station presses and eliminates all manual handling of the parts.

valves, cylinders, etc., are the best that can be obtained for the service and are properly applied. More limit switches fail because they are improperly installed than because they are overworked. The greatest cause of their failure is forcing the switch arm beyond its limit of overtravel.

The designer is offered several choices of drives for his automation devices. Hydraulic drives in general have been found to be slow. In addition, they present a maintenance problem due to their tendency to develop leaks. Some plants use air to operate all loading and unloading devices and to operate shuttles. Other plants use air for some devices and electrical drives for others. The possibility of using a mechanical drive taken directly from the press, unfortunately, has not been thoroughly explored. It is a positive drive and where it can be used will give a good account of itself. The choice is one the designer must make to suit his conditions.

Electrical controls for these mechanical handling devices are basically quite simple, although due to the need for complete interlocking, they sometimes become quite bulky. The control equipment will usually consist of motor starters, control relays, limit switches, timers, electrically operated valves, selector switches, pushbuttons and indicating lights. Most modern presses are equipped with mechanically driven rotary cam limit switches for the automation circuits. These switches can be easily adjusted to operate at any point in the press cycle and will retain their accuracy of setting. The Danly cam limit switch is designed so that the final fine adjustments can be made from the outside of the switch while the press is in motion. This switch is used to start the loading operation and the unloading operation. Other operations are usually controlled by standard limit switches, or sometimes, photoelectric cells.

Mechanical designers should provide mounting space on each device for the control equipment associated with that device. These mountings should protect this equipment from mechanical damage and from dirt. Connections from the devices to other equipment should be by means of polarized plug connections that are not the same as the regular connectors used throughout the plant.

Each device should have a tryout circuit to allow the maintenance man to check its operation without exposing himself to the dangers of moving parts or without affecting the other devices in the line. Also, the control circuits should be arranged, whenever possible, so that if the line is stopped, restarting will pick up and continue the cycle from the point at which it was stopped.

One overall consideration which should be kept in mind is that the justification for the use of automation or mechanical devices is, and always will be, on an economic basis. Regardless of cost, if it can be shown that a device will pay for itself, it will be built and used; if it cannot pay for itself the old fashioned methods will have to be good enough.

AUTOMATIC FEEDING
INCREASES
GRINDER PRODUCTION

AUTOMATIC LOADING of screw machines is a well established technique of improving productivity in machine shops where bar stock is used in quantity. However, often overlooked by shop operators is the fact that many one-pass centerless grinding operations have the same loading characteristics as those commonly encountered with screw machines. With modern handling equipment, automatic loading techniques can easily be adapted to centerless grinding.

An operation at Bendix Aviation Corp.'s Scintilla Div. offers one of the best current examples of automatic loading in a centerless grinding operation. Production of the Scintilla Div. centers on ignition systems and auxiliary equipment for all types of aircraft, industrial, automotive and marine engines. Other principal products include magnetos, Diesel fuel injection equipment and electrical connectors.

Production schedules require a large quantity of precision ground tellurium copper and brass bar stock for subsequent machining into pins for the sockets of electrical connectors. Sufficient bar stock must be precision ground in the shop to insure steady production from each of 18 screw machines. Need for the precision ground stock is based on the use of Swiss-model, rather than conventional, screw machines; any taper in the stock going into the screw machines will result in a distortion of the finished pieces produced. As an indication of the size of the operation, about 2 million feet of stock are required to fill the annual demand for the electrical connector socket piece.

Prior to using automatic loading in the centerless grinding operation, Scintilla operated four manual-load centerless grinders on a three-shift basis, with one man per shift assigned to each pair of machines. As an improvement in this setup, an automatic magazine loading bar feed was teamed up with an advanced model Cincinnati centerless grinder, *Fig.* 1. The air-operated automatic bar feed is a development of Lipe-Rollway Corp., Syracuse, N. Y.

Here is how the bar feed operates in conjunction with the centerless grinder: Bar stock in 12-foot lengths is racked in the magazine along one side of a split stock tube. The lower half of this

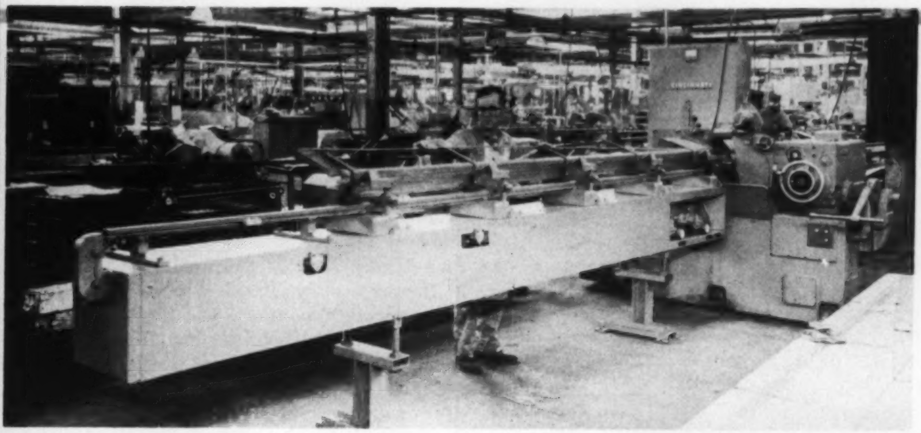


Fig. 1—Stock is precision-ground at a rate of 12 feet per minute in a Cincinnati centerless grinder automatically fed by a Lipe-Rollway Corp. automatic magazine loading bar feeder.

tube slides backward to receive the bottom bar as it drops from the gravity type magazine. Then the stock tube closes, and a pneumatically activated stock pusher moves the stock into the collar of an infeed tube on the grinder, *Fig.* 2. When the stock pusher reaches the entrance of the infeed tube, it is automatically retracted and the cycle is repeated. In the grinder, stock is ground to a diameter tolerance of 0.0005-inch at a rate of about 12 feet per minute—a relatively high speed for so exact a tolerance. Stock removal averages 0.005-inch.

Stock, after being ground, passes into and through an outfeed tube—needed as an aid in close control of tolerances during grinding—and into an ejection trough. Timing of the automatic feed-out allows a gap of 10 inches between the end of one bar and the start of another. Passage of the full length of the stock into the ejection trough activates a limit switch which, in turn, causes the trough to tip through a one-quarter turn, so that the finish ground stock is deposited into a stock bin, *Fig.* 3. Stock is collected and transferred as needed to the screw machine bay a few yards away.

It has been determined that setup of the bar feed takes 5 minutes or less. Even though straight production runs average two or more days, it has been found profitable to use the automatically loaded centerless on runs of only a few hours.

The automatic magazine loading bar feed has made it possible for the new centerless to be operated at 90 per cent of capacity or above. The bar feed's magazine can be loaded or replenished with stock at any time—before or during operation of the grinder—and holds upwards of two hours' supply. This frees the operator to give the bulk of his attention to the manual load grinder. A better idea of what this means in terms of increased production and resulting reductions in production costs can be obtained from an analysis of the two machines in the present grinder arrangement: the manual load grinder produces 28 bars per hour; the feeder equipped grinder produces 44.8 bars per hour.

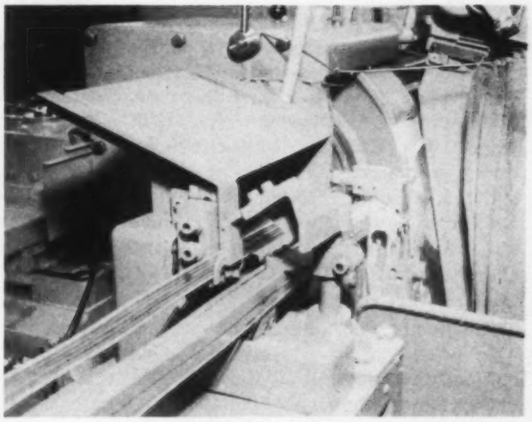


Fig. 2—Bars are fed into the grinder by a pneumatically activated stock pusher which operates within a split stock tube. The photograph shows the stock tube, which is closed about a bar, at the point the bar feed equipment connects to the grinder.

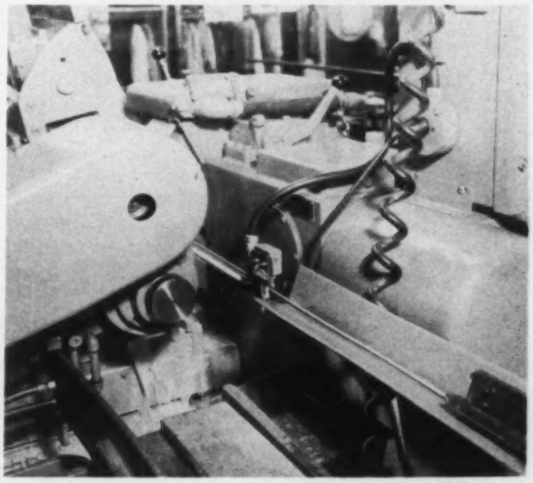


Fig. 3—Outfeed end of installation is equipped with special trough to receive bar as it leaves grinder. Limit switch senses when a bar is completely free of grinder and trips the trough to discharge bar into bin below it.

AUTOMATIC X-RAY INSPECTION OF AMMUNITION

INSPECTING the explosive charge in a shell or other ammunition items has always been a difficult task. Since 1943, such inspection has been done mostly by x-ray photographs, which are read by trained x-ray technicians skilled in detecting flaws, cavities, impurities, etc. in the explosive charge. The X-Ray Dept. of General Electric Co. has built a machine which automatically inspects the explosive charge in 3.5-inch rockets, *Fig.* 1, utilizing principles of similar automatic x-ray equipment previously limited to checking the level of liquids and free-flowing solids in containers (See—AUTOMATION, Feb. 1956). Automatic inspection by machine rather than by humans has three important advantages: It is more certain and more foolproof because the possibility of human error is greatly reduced; it saves large sums of money by requiring fewer inspection personnel and by eliminating the use of x-ray film; and it relieves the shortage of x-ray technicians that arises during periods of military emergency.

In production, newly charged rockets are automatically transferred from a conveyor to a circular inspection platform. At the center of this platform is a conventional 250,000-volt x-ray machine which sends x-ray beams fanning out to six inspection stations located around the rim of the platform. Each rocket moves around the circular platform from one station to the next. At each station, the fixture is at a different height relative to the x-ray source and consequently different parts of the charge are exposed to the x-ray beams. If the rocket's explosive charge is sound and uniform, a normal amount of x-ray energy is received by a stationary receiving head containing a crystal receiver and the rocket passes on to the next station. However, if the explosive charge contains flaws or defects, an abnormal amount of the x-ray beam passes through the rocket and strikes the receiving head. Each receiving head contains a cadmium selenide crystal, a member of an important new family of semiconductive elements, which, when excited by receiving x-rays, allows the flow of large quantities of electrical current. The current feeds into a digital computer which evaluates any increase and determines whether the amount of x-ray beam passing through the rocket indicates a defect serious enough to justify rejecting the rocket. If it does, the computer sends out an electrical signal that causes a mechanical arm to strike the rocket and mark the place where the defect is located. Rejected rockets are removed for rework. The machine contains eight digital computers, one for each inspection station plus two spares. Though the machine is specifically designed to inspect 3.5-inch rockets, the principles and working parts of this first machine can be readily adapted to future machines that will automatically inspect many other types of ammunition such as artillery shells, mortar shells, land mines and grenades.

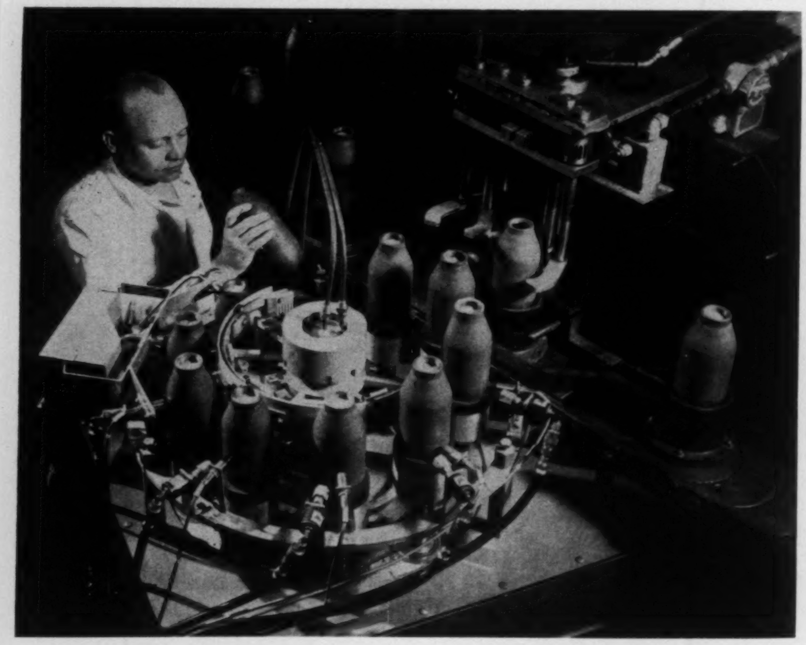


Fig. 1 — Single source of x-rays, located in center of inspection machine, sends out beams through 3.5-inch rocket shells to stationary receiving heads in inspection operation. Different areas of the charge in a shell are inspected as each shell is indexed through the six-station machine.

CHARACTERISTICS

Gain · 39 db (voltage gain)

Bandwidth · 10 cps to 40 kc (± 1 db)

Maximum undistorted output
500-kilohm load, 25 volts rms
100-kilohm load, 14 volts rms
Intermodulation distortion < 2 per cent

Power supply: 250 volts dc
6.3 volts at 350 ma or
12.6 volts at 175 ma

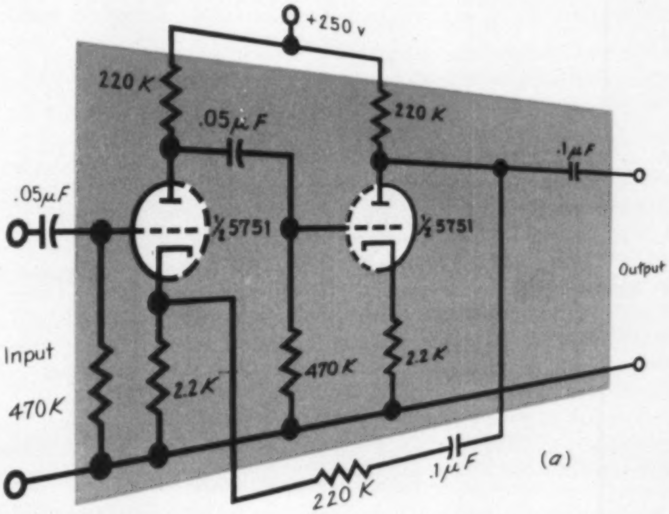
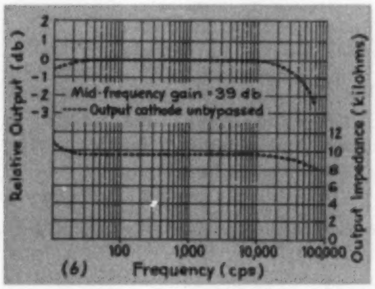
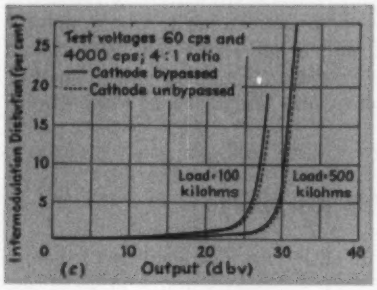


Fig. 1—Amplifier shown in *(a)* is useful in applications requiring moderate gain over the entire audio range. Negative voltage feedback is sufficient to provide considerable immunity to tube and supply voltage variability. Amplification and output impedance versus frequency is shown in *(b)*. Intermodulation distortion versus output level for two values of load resistance is shown in *(c)*. Since in some applications it will be undesirable to bypass the output cathode bias resistor, performance data have been included for conditions of operation with and without bypassing. For any variation in tube characteristics, the gain is a constant 39 db.





ELECTRONIC RELIABILITY

CAN BE DESIGNED-IN

By J. ROY SMITH
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U. S. Navy Electronics Laboratory
San Diego, Calif.

No longer is it possible for the designer of electronic equipment (or for that matter any industrial product) to be satisfied with the birth of an idea. In order to insure reliability for his brainchild, he must adopt a "from conception to the grave" concern—design for function, manufacture, utility and maintenance.

DO WE NEED to concern ourselves with reliability? Is there anything wrong with today's electronic equipment? Unfortunately, affirmative answers to these questions must be obvious to all. There are entirely too many equipment failures. When these failures are studied, it is found that the majority could have been prevented by designers, many prevented by manufacturers, and a few by service and operating personnel.

What are the areas of responsibility wherein the designer has influence? The answer is in just about all areas between conception and operation—in the selection of parts, the application of parts in the design of functions and circuits, the engineering of the total product, and in the engineering of simplified maintenance. Mr. Design Engineer indeed has a great deal to say in deter-

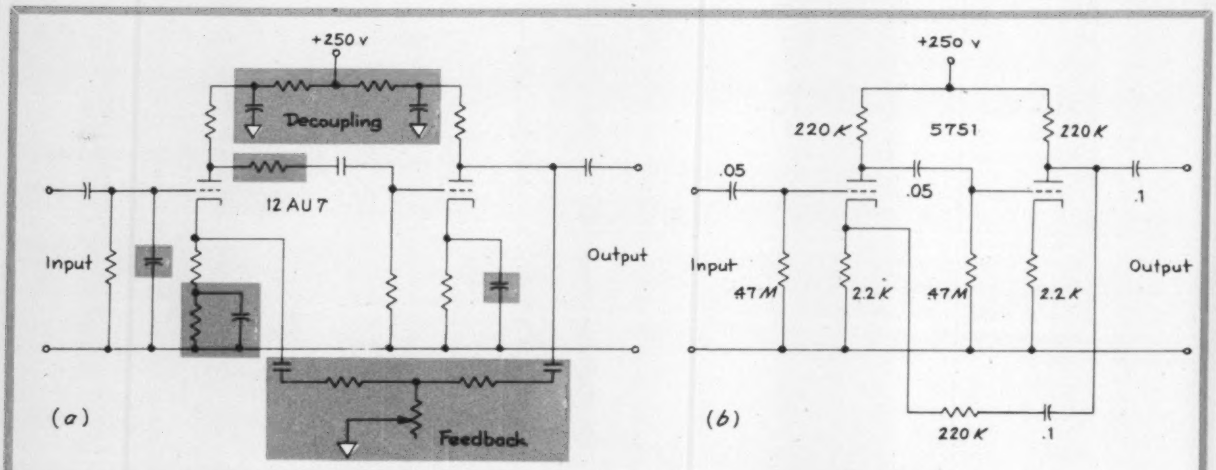


Fig. 2—Typical audio voltage amplifier (a) found in use in several experimental pieces of equipment and (b) simplified audio voltage amplifier. Shaded areas in (a) indicate circuits eliminated or revised. The decoupling circuit was found unnecessary. Tube bias networks were simplified and bypass capacitors eliminated. Unbypassed cathode resistors added stabilization and degeneration eventually considered desirable. The negative feedback circuit was redesigned with sufficient feedback that adjustment for different tubes and tube aging was automatic, eliminating need for the previously used adjustment resistor.

mining the reliability of electronic equipment.

Reliability too often is hampered by unnecessary complexity. High-level military planners often ask for equipment that does too many things. To accomplish all the requested objectives, the inexperienced designer often resorts to circuits and functions far too complex to be consistent with reliability.

Also, eagerness to meet deadlines often causes bypassing of diligence in design. Previously-used circuits with their past faults are recopied and used without checking the design. Inadequate consideration is given to ratings, thermal environment, and environmental motion.

Good product engineering—the proper changeover from breadboard model to production model—is a tremendous hurdle blocking the way to reliability of electronic equipment. It can never be cleared by engineers who fail to keep in mind the purpose and intended environment of the final product.

Tubes are the greatest cause of failure. Yet, equipment development continues along lines which call for increasing numbers of tubes. Equipment having an unlimited number of tubes is relatively easy to design; it is much more difficult to utilize fewer tubes in the design and still meet the same requirements. It takes more "doing" to make equipment more simple.

What about maintenance? Designers are so intent on doing their own job that they forget about the phases of design which aid maintenance. Too many prefer to cross such bridges when they get to them, or to detour them entirely.

These and other aspects of designing reliability into electronic equipment, Table 1, are the subject of this article, and are brought out in the hope that they will stimulate some designers to further improve reliability and simplicity of their equipment.

▶ Designed-In Reliability

Studies of failed electronics equipment reveal that a majority of the causes were unwarily designed into the equipment. "Let the next guy worry about reliability, I haven't time," is the frequent sentiment.

Reliability must be a prime consideration from the initial moments of the concept stage—even during the earliest development study. Many designers, working only on a portion of an equipment, concern themselves solely with their own function and give too little attention to the problem of overall reliability.

Factors such as simplicity, producibility, maintainability, and reliability are essential ingredients in engineering design. Such factors should have an important influence on the choices involved in designing reliable equipment.

Many research people balk when asked to consider reliability in advanced stages of their work. They claim that they deal with ideas only and should not concern themselves with the equipment itself. But consider their work for a moment. They do investigate ideas, of course. Furthermore, the ideas require experimentation. Experiments must be implemented, perhaps with special instruments or special equipment, and sometimes with unusual circuits. Their experimental results are measured and evaluated. Reports are written containing photographs of instrumentation, circuit diagrams, and recommendations. The reports are sent to various technical agencies or bureaus. When military forces require new or special equipment, some of these researcher's ideas are considered. At this point the technical agency gathers all the applicable reports and presents them to an equipment development and manufacturing activity as the "prior art" most applicable to the problem. All too often the manufacturer uses these ideas and the associated circuitry without doing the redesign needed for increased reliability. This is especially true in "crash" programs where time is short. Hence, the researcher's disregard for reliability leads to the downfall of the final equipment.

Reliability improvement depends, first, upon the attitude of the designer. Design engineers and scientists must recognize past failures and assume a helpful, healthy attitude toward efforts to improve their designs and equipment. Secondly, reliability improvement depends on a program of education. Engineers and scientists must educate themselves about the causes for unreliability. Designers must think reliability, live reliability, and dream reliability.

Management must take a keen interest in the problem. Management can participate by encouraging designers to consider reliability as a vital design parameter and by rewarding diligent efforts to improve reliability. There is a need for management to deliberately specify reviews of reliability factors as required stages in the development process. A design review board is needed to pass upon the service-dependability and intended-life requirements met by each design.

▶ Selection of Component Parts

Reliability, insofar as design is concerned, has been found to depend to a great extent upon the quality of parts specified for use. Excluding electron-tube failures, about 30 per cent of equipment failures are attributable to parts properly applied but unreliable because of inherent defects. Of course, some parts are better than others. Excellent guides for selection of parts are: Military Standard MIL-STD-242 (SHIPS) "Electronic Equipment Parts (Selected Standards)"; Armed Services Electro Standards Agency publication ASESA 49-1 "Preferred Parts List"; plus similar other publications.

A part is selected as preferred on the bases of superior quality and availability. A part with a single source of supply is seldom selected as a preferred part even if it is superior to similar parts. Of course, parts of inferior quality are almost never considered as preferred parts. Preferred parts are certified by electronic parts agencies for use in new developments of electronic equipment. The certification of these parts is based upon the characteristics and quality of the parts as determined by tests and by histories of failures, and upon careful standardization of types and values to simplify the logistic supply for future use and replacement.

Use of good parts and their contribution to reliability must be considered as early as the initial concept stages of research and development to insure the reliability of the final product, no matter how remote that final product may seem to be. Reliability definitely is improved by the use of good high-quality parts, even in the initial breadboard stages. Frequently, parts of doubtful quality used in design and development models find their way into the production of military equipment and result in repeated equipment failures.

Approved preferred parts initially cost more than ordinary commercial-grade replacement-type

TABLE I

Twelve Points For Proper Parts Application

1. Keep in mind the environments the equipment must meet in the field (shock, vibration, temperature, humidity, salt spray, etc.).
2. Know electronic parts and their limitations. Know circuit conditions under which parts operate best.
3. Use military preferred reliable parts in all applications possible.
4. Compensate in equipment design for known limitations in parts.
5. Apply suitable margins of derating factors (safety factors) to compensate for variations encountered in use.
6. Use prescribed derating factors for temperature effects, especially of resistors, capacitors, and tubes.
7. Guard against voltage overload and excessive current.
8. Position parts in the equipment so that the heat radiated by surrounding parts and the temperature rise in individual parts and circuits do not exceed maximum safe operating temperatures.
9. Arrange parts so that they are easily accessible for testing and maintenance.
10. Provide adequate ventilation. If necessary, add blowers to keep parts within safe operating temperatures.
11. Protect equipment with fuses, meters, etc., to prevent damage from unexpected operating conditions.
12. Check circuit function with random selections of tubes. Determine if shifts in tube characteristics or normal aging are likely to affect operation during the desired life of the equipment.

parts, but their use is justified. Should an equipment fail because of a cheap part, the time spent on trouble-shooting and maintenance effort represents a much greater expense than that which the additional cost of a reliable part would have been. The price of parts has been estimated as representing only about 10 per cent of the total cost of the equipment developed; if the cost of parts were doubled, the percentage still would be low. Savings in time used for trouble-shooting alone offset the added cost of good parts. The cost of maintenance of military electronic equipment in service is 10 to 100 times the original purchase price of the equipment.

Preferred values of parts are important, especially in regard to design compromises and equipment maintenance. They are important because they provide a frame of limitations within which engineers must keep their designs and circuits. Preferred values are the result of a standardization of parts values. Standardization is a good thing, useful in practically every endeavor. However, it can be carried to extremes. As experience accumulates in parts application and manufacture, standardization of parts values will become even more judicious to further increase reliability. Preferred value programs are established upon systems of preferred numbers on a logrithmic or percentage-change measure. Practically all engineering involves compromises of values. Preferred values may not always fit the job but in all probability will satisfy at least 80 per cent of the applications. And as a bonus benefit, fewer parts will be needed in stock to replace the fewer part values required in equipment.

▸ Engineering Applications

Applications engineering—applications of electronic parts, circuits, and construction techniques—is the next major area of concern for designed-in reliability.

In the application of parts one must consider application ratings, variation effects, and other factors affecting the useful life of parts. Equipment which operates satisfactorily through changes of ±50 per cent in parts values is considerably more reliable than those which cease operating when parts vary from original values. Engineers should strive to design circuits which accept wide variations in parts tolerance, stability, and stamina.

There are two schools of thought about proper parts application: (1) Designers should use only selected, preferred, reliable and proved parts; (2) any and all parts when sufficiently derated can be considered reliable in application. The first concept is assuredly good; the disadvantage of the second is that many parts need to be derated almost to zero to be considered reliable in application, and even then there is considerable doubt concerning reliability. The best compromise is to use good parts with enough derating.

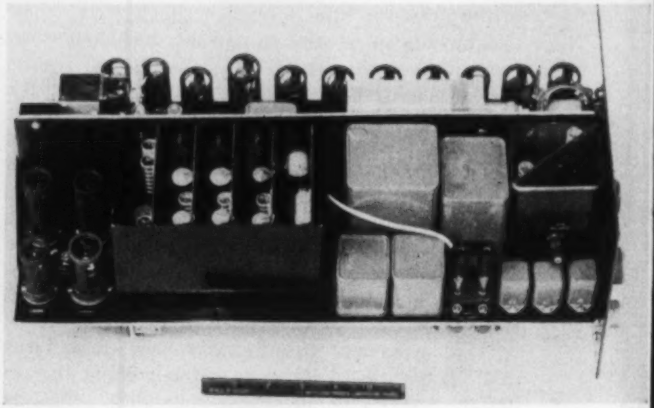


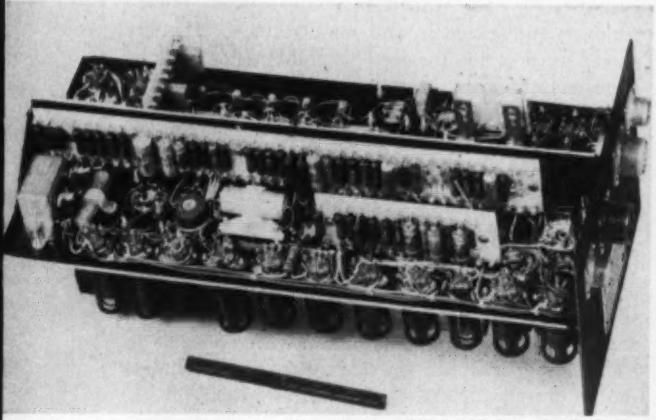
Fig. 3—Ease of maintenance is increased by making all parts accessible for visual inspection and parts replacement. Photos show top and bottom views of equipment design where accessibility was a prime consideration.

Before a design is frozen, a good plan is to consider each part separately. Examine the derating of each part with regard to voltage, current, temperature, frequency, and derating for signal waveshape and amplitude. The publication "Application Design Notes (Electronic Components)" by ASESA (Armed Service Electro-Standards Agency, Fort Monmouth, N. J.), Publication 51-4, is the best source of derating information on specific types of parts.

A general rule of thumb for derating of power handling components is 50 per cent of rated wattage. Voltage ratings are in general dependent upon dielectric strength and environment (humidity, salt spray, etc.). Current derating of capacitors is important in circuits with rf currents. Use of electrolytic capacitors should be avoided, but, when used, the dc working voltage should be above 50 per cent but not over 80 per cent of rated working voltage. All current carrying parts need further derating when the temperature exceeds 80C.

Designers of electronic equipment should give considerable thought to the questions, "Does each part meet the needs of the particular application?"; "Is each part an approved preferred part?"; "If not, has its use been military approved?" Designers should know the approved parts—know their limitations as well as the circuit conditions under which they operate. They should compensate in equipment design for component weakness, and consider the maximum tolerances allowed in any electronic part specifications. A designer can contribute materially to equipment reliability by using military preferred parts.

Preferred voltages, like preferred parts and preferred values, represent judicious choices and com-



Official Photographs, U. S. Navy

promises by groups of designers. Filament voltages are somewhat standardized. Anode voltages, on the other hand, are usually left to the discretion of the designer and, to a degree, to the ratings of the parts available.

As a result of a recent Navy Department and industry meeting of the Committee for Reliable Subassemblies, an agreement was reached to recommend 150, 250, and 300 volts as the preferred voltages for either positive or negative supplies.

Why use preferred voltages? It is another standardization effort. If one must use anode voltages, why not use a preferred one if it meets the requirements? The reliability of equipment is enhanced by the right selection of these voltages with regard to reasonable derating. When preferred voltages are established, parts manufacturers can refer the operating characteristics of their parts to the preferred voltages. These preferred voltages then may serve as a common language or as common denominators in the application of parts.

In selecting the preferred voltages, considerations were given toward previous selections of voltages applied and the reasons for those voltages. The selections then were tempered by new design trends and added deratings for reliability. For example, there exists a design trend to perform such electronic functions as frequency multiplication, conversion, and selection, and electronic timing and counting, mixing, and modulation at low amplitudes and then amplify to get useful output levels.

▶ Circuits

Preferred reliable circuits are those which have been designed, built, tested, and evaluated with performance, reliability, and simplicity firmly in mind, *Fig.* 1. These are circuits in which previous mistakes, unreliable features, and poor designs have been eliminated. Such a circuit more than likely will have several uses—can be successfully applied to different equipments. The use of applicable preferred reliable circuits relieves the designer of working on circuits which are repetitious from equipment to equipment, and allows him more time for the design of circuits which are peculiar to the equipment at hand. Furthermore, preferred circuits help the maintenance technician; he needs to be familiar with fewer circuits which allows him to do a better job easier.

Four basic requirements of preferred circuits are: (1) Must be as simple as practicality allows; (2) use tubes and parts within their limits, tolerances, and aging characteristics; (3) remain stable under all intended environments (temperature, humidity, shock, vibration, and voltage variation); and (4) be conservatively designed with adequate derating factors. The *Handbook of Preferred Circuits* (Bureau of Aeronautics publication NAVAER 16-1-519), by the National Bureau of Standards, is probably the most outstanding example of preferred-circuits work.

Overly complex circuits contribute to unreliability. The more parts in a system, the greater the chances are for parts failures and, consequently system failure. Given a set of equipment requirements, it is relatively easy for the designer to accomplish the job with many tubes and many circuits. Though increasing the difficulty of his job, diligence by the designer in reducing the unnecessary links in the chain contributes much toward increased reliability. Usually the simplest device is the most reliable.

Circuit simplification may be applied after the completion of preliminary design, *Fig.* 2. However, it would be better if circuits were developed with simplicity as the first consideration (compatible with the more basic requirements, of course). Such a development would start by recognizing only the essential or key requirements—the minimum requirements that would justify the efforts. This does not mean that other requirements would not be picked up later and met in the final design. At the start, the engineer would design the simplest circuit compatible with performance. A breadboard or trial unit would be built and tested. If it met the essential objectives, it would become the basic design. At this point, the designer would examine each of the other requirements to see if they could be met with simple variations or additions to the basic design. Less essential requirements adding greatly to complexity should be rejected as being beyond the margin of diminishing return.

Often reliability is foredoomed by the multiplicity of operational requirements placed upon equipment. The tendency is overwhelming for these requirements to become all inclusive as a proposed equipment is being planned. This is the natural result of planners trying to get the most from equipment. But for the sake of reliability it behooves designers to question these planners as to the absolute necessity for all the requirements. Often, if some requirements can be relinquished, many of the objectives can be met with designs of more inherent reliability.

An improvement program wherein quality is improved or at least maintained while the system and all parts are questioned as to their value in relationship to one another is known as value engineering and can be applied to electronics equipment in both the electrical and mechanical aspects. Subdivisions of circuits and assemblies are analyzed to see if they contribute worthy value for the use, effort, and expense involved. Each bit and piece is questioned to see if it is needed, if it does its job in the simplest and best way.

Product Engineering

Product engineering involves the transition from a developmental or experimental model to a prototype mode. If the problems of product engineering are considered while the equipment is in the breadboard stage, reliability of the end product will be enhanced.

Problems of product engineering involve considerations of the intended environment, techniques of construction, mechanical design, and arrangement of parts. Perhaps this phase of engineering should be done by a mechanical engineer having a good understanding of reliability and a working knowledge of electronics. However, it would be better to have a task group consisting of a mechanical engineer and an electronic engineer, both well grounded in reliability, to do the product engineering.

Mechanical structure and enclosure must be strong enough but not excessively strong. Strap iron or boiler plate should not be used for strength. Chassis and enclosure sheet-metal work should have the desired strength, with sections of high moments of inertia kept at minimum weight. Lightness helps solve another problem—that of shock and vibration. The less mass receiving the environmental motion, the less is the damage that is likely to be encountered. Precision mechanical linkages and gears should be kept to a minimum. Likewise, in forming sheet-metal structures, stress points and sharp bends with less than the minimum safe bend radii should be avoided.

Product engineering usually involves a reconsideration of the choice of parts, circuits, and electronic methods with a look toward feasibility of production and operation. This reconsideration takes into account the arrangement and orientation of parts for minimum wiring and minimum lead lengths. Short wires keep down feedback and undesired coupling.

Design for Maintenance

To be realistic, it must be admitted that today's electronic equipment cannot be made completely reliable. Hence, the designer must consider and prepare for the inevitable consequent failure which requires repair and maintenance. The designer must strive for ease of maintenance because good maintenance provisions cannot be put into equipment after it has been built. Ease of maintenance must be designed-in, just as must reliability. The design engineer with experience in repairing failed equipment in the field is obviously the best man for this job.

Preventive maintenance or maintenance-to-prevent-future-maintenance, as commonly understood, is of little value in electronic equipment—in fact it is highly detrimental. The technician looking for trouble will surely find it or unwittingly cause it. Electronic parts fail on a random basis (unless due to design application faults), and their life expectancy is still largely unpredictable even after a reasonably long time. The usual practices of thorough chassis cleaning, moving parts to see if they are tight in continuity and mooring, and pulling tubes, cause failures. "If the equipment works, keep your fingers out of it," is a harsh but true statement. The important job is to determine if the equipment is working satisfactorily.

Performance evaluation techniques are the most important measures for determining satisfactory operation. Ways are needed to determine degrees of performance and the tolerances of performance. If the performance is within tolerance, do not touch (i.e., maintain) the equipment. If the performance is below standard, corrective maintenance should be applied.

What are the means for accomplishing performance evaluation? They are the built-in evaluation devices, the simple test procedures, and the logic of the design arrangement itself. It is preferable that the built-in test devices and operational test procedures be simple enough to be performed by the equipment operator.

Marginal checking or testing is a method of performance evaluation worthy of consideration. Marginal checking is a procedure wherein the operating voltages (and sometimes current and power) are raised and lowered from normal and the overall performance change is observed. These changes in performance are then compared with normal standards. Sometimes the performance change is a failure to operate, necessitating corrective maintenance. On the supposition that failure is predestined, the marginal checking technique might be considered as bringing on the failure at a more opportune time. Marginal checking techniques vary with each type of equipment and therefore require considerable planning and design.

In designing for ease of maintenance, the greatest return for effort is to make all parts and assemblies accessible for visual inspection and replacement, *Fig.* 3. Generally, if a fault is not known the most effective procedure for trouble shooting is to start the fault-location process by a complete, 100 per cent visual inspection of all parts. A large majority of equipment failures are located easiest by inspection. Such failures show as burnt sockets and terminals, tube filaments not glowing, pilot lamps out, and wires disconnected or broken. In compact and crowded equipment it may be necessary to depend upon removable plug-in assemblies to achieve accessibility but regardless of the amount or kind of work required to obtain accessibility, it is worthwhile. To reduce the likelihood of the recurrence of failures, faults visually located should be analyzed for their causes before the replacement of defective parts. Next to accessibility, fault-locating systems help most to provide easy maintenance. An excellent fault-locating system is a systematic but simple test procedure to determine wave shapes and to measure voltages by test points or switched connections.

Provision for easy maintenance and fault location is one of the more important justifications for unitized construction and standardized assemblies of the kind which may be tested within the equipment or quickly removed to a special test fixture.

Another item which will promote ease of maintenance is to abolish the old, obsolete manufacturing procedure of making wrapped-wire connections around terminals prior to the application of solder. Those solder soaked, knotted joints are unnecessary[1] and make parts replacement extremely difficult. Simple soldered connections are adequate for all environments provided that large parts and wiring harnesses are clamped down to prevent the relative motion which fatigues wires, and causes failure.

Effect of Automation

What is the relationship between automation and reliability? Each can benefit the other considerably. A design for automatic-production equipment has a certain finality about it. Automation usually is expensive for limited quantity production, and it is expensive to change a setup to make design changes. These factors cause engineers to ask themselves before turning the design over to the equipment builder, "Is the design really completed for automation?" The designer must be sure that reliability, performance, and the required maintenance are designed into the equipment as later will be too late. Automation causes engineers to "read the label before taking the poison."

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[1] "Reliable Soldered Connections Without Mechanical Joints" by J. Roy Smith, *Electrical Manufacturing* Sept. 1956.

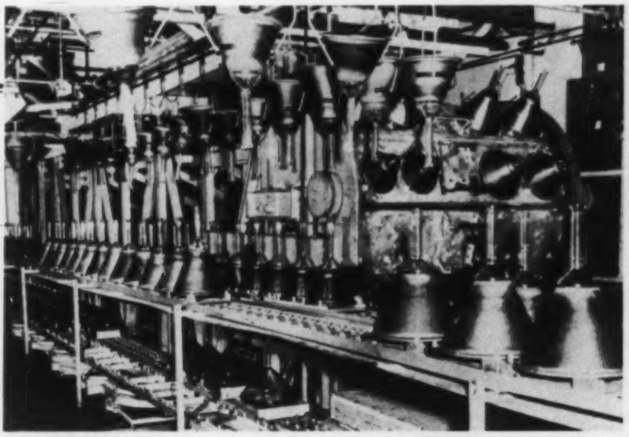
Conveyor Times Liquid Suspension Settling

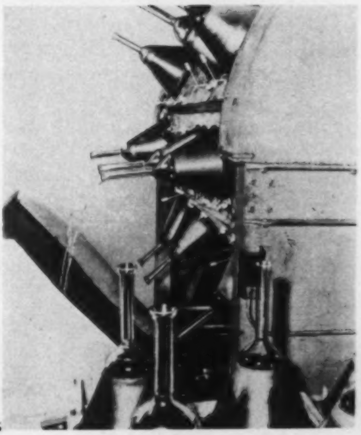
MANY OPERATIONS are direct functions of time—the process must "sit" until a reaction or change is completed. Conveyors may be used in such instances, not for transportation, but for timing and introduction of the flow concept in an essentially batch type operation.

Both of these peculiarities—timing and the flow concept—are utilized in conveyor systems installed in the plants of several TV picture tube manufacturers by Allied Steel & Conveyors. These systems were designed as an answer to the problem of coating the inside surfaces of TV tubes with an even film of phosphorescent material at increased production rates.

The tube settling conveyor is in the form of a continuous "over and under" loop about 40 feet long. Approximately 5 gallons of solution are poured into each tube after the tube is fixed to the conveyor. The film of phosphorus settles out of this liquid and deposits on the inside surfaces of the TV tube. At the opposite end of the conveyor loop the solution is gently poured from the tubes as they are inverted to pass along the underside of the loop for drying.

A particularly critical requirement of the conveyor system was elimination of vibration and jarring. The slightest quiver can cause ripples in the liquid which in turn causes ripples on the surface of the screen. When the operation was done by hand rejects due to rippling were close to 50 per cent. The rate traceable to this cause in the present type of equipment is now less than 3 per cent.

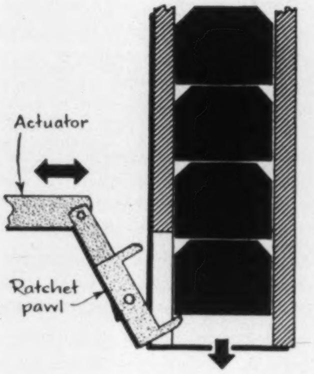




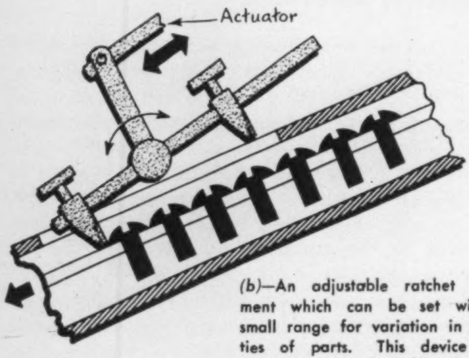
ESCAPEMENTS

Devices which regulate the release of parts or quantities of materials in controlled amounts at desired rates are essential in all types of automatic equipment whether cyclic or continuous in operation. Careful consideration and, often, flames of inspiration are required in the design of these escapements. This article illustrates some basic types which may spark solutions for the reader.

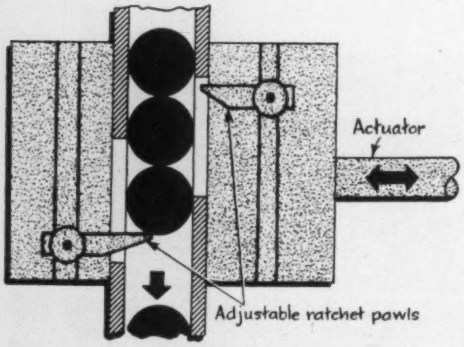
Fig. 1—Ratchet escapements are similar to the familiar method of regulating timepieces. True ratchets may be replaced by separate fingers or pins individually actuated in proper sequence. Such escapements can be used to escape items singularly or in groups, in series from a single track or in parallel from multiple tracks.



(a)—Ratchet setup to release one stamping for each cycle of the actuating device.

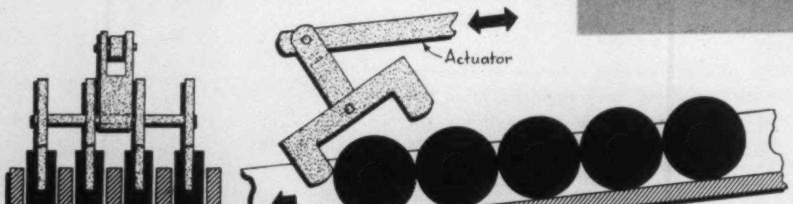


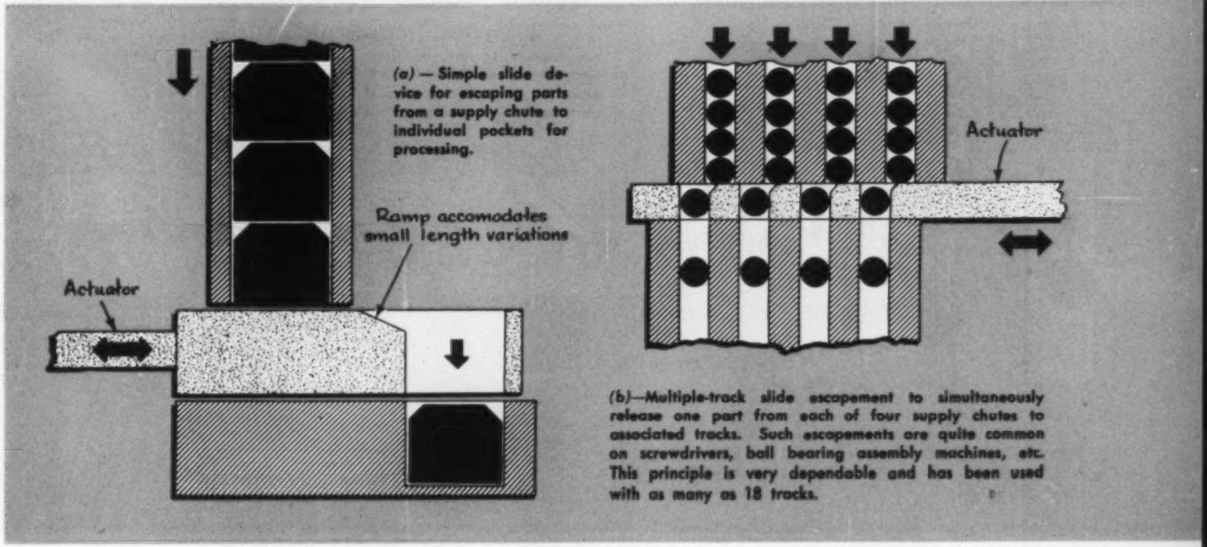
(b)—An adjustable ratchet escapement which can be set within a small range for variation in quantities of parts. This device offers the advantage of working for multiples of various size pieces as in packaging work.



(c)—This is a compromise between a slide and a ratchet escapement which is adjustable for a wide range of part sizes or quantities. While more expensive than (b), the range and ease of setting up this device make it quite practical.

(d)—Ratchet escapements can of course be designed to control release of units from several tracks simultaneously with one actuator and one timing impulse.





(a)—Simple slide device for escaping parts from a supply chute to individual pockets for processing.

(b)—Multiple-track slide escapement to simultaneously release one part from each of four supply chutes to associated tracks. Such escapements are quite common on screwdrivers, ball bearing assembly machines, etc. This principle is very dependable and has been used with as many as 18 tracks.

Fig. 2—Although parts can move through ratchet escapements in straight lines, slide escapements involve a change in direction of motion of the material escaped.

FOR AUTOMATIC EQUIPMENT

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Gray Equipment Co.
Cleveland, Ohio

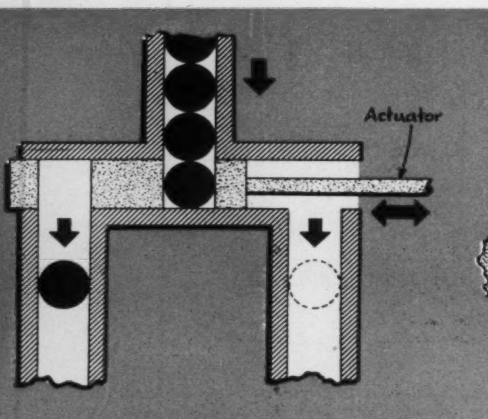
INDUSTRIAL ESCAPEMENTS are frequently not consciously recognized as such. Fixtures on dial tables may perform the function of escaping parts from magazines or feeder tracks; punches on punch presses may escape parts from chutes as the punches travel to perform their forming or fastening function. In order to identify the actual escaping function this article will classify escapements according to types such as ratchet, slide, drum, gate, displacement, and jaw. This cross-section of basic types can be combined and adapted indefinitely to individual needs of the moment, limited only by the ingenuity of the applier. All of the illustrated escapments are in current use in one form or another.

▶ Escapement Types

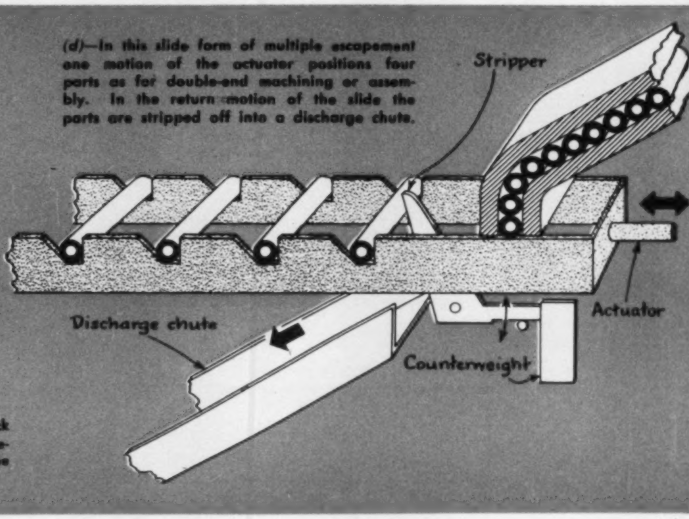
Ratchet: Ratchet escapements, *Fig.* 1, have been used for many centuries. Their most common application is probably found in the timepiece, where the commodity released is shaft rotation resulting from stored spring energy. The release may be in accordance with the timed impulses from a pendulum, whose natural frequency is controlled by its design. The modern watch contains an oscillating balance wheel whose inertia is carefully adjusted to provide the proper timing. This balance wheel controls a ratchet to regulate rotation of a ratchet wheel and shaft. If the ratchet wheel is replaced with disks, gear blanks or other parts to be escaped, the ratchet will then release one or more parts into fixtures for machining or assembly, or into containers for packaging. Though several true ratchets are shown, such escapements may be operated by cams which insert and remove fingers, or may be spring-loaded fingers pushed in by cylinders or solenoids, etc.

The author would suggest that the most logical applications for the ratchet escapement exist where a straight lineal motion of parts is desired. Where the escaped commodity is other than physical parts as in a timepiece, the motion may be rotary.

Slide: Slide escapements, *Fig.* 2, usually involve a change in direction of motion of the commodity to be escaped. This direction change may only be a "jog" in the material flow, but without the use of some ratchet device a slide escapement must change flow direction to operate. *Multiple-track slide escapements* feed more than one track, but each has its own supply track. Such escape-



(c)—A multiple escapement feeds more than one track from a single supply track or chute. In this double-escapement unit one recess is being loaded while the other discharges.

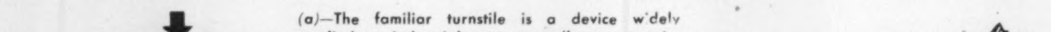


(d)—In this slide form of multiple escapement one motion of the actuator positions four parts as for double-end machining or assembly. In the return motion of the slide the parts are stripped off into a discharge chute.

ments are quite common on screwdrivers, ball bearing assembly machines, etc. *A multiple-escapement* slide feeds more than one track from a single supply track. In the feeding of stacks of parts or sheets, slide escapements are limited by burrs, variations in coatings, cleanliness, etc., but this is one use of the slide method.

Drum: Turnstiles at the local baseball park are a very familiar form of the drum escapement, *Fig.* 3. In this form it separates the patrons and spaces them for counting purposes. Although we all dislike the bottleneck at the ball park, the escapement does control and regulate the commodity being released. A similar type of drum escapement is that commonly known as a star wheel. In the coin counter application shown, the star wheel itself does not actually time the release of the coins. The rotating drive wheel feeds the coins as rapidly as the mechanism will function. The star wheel serves to separate the coins and actuate a counter. Speeds of more than 20,000 counts per hour are possible. This arrangement is of added value since it will count only coins of the proper diameter and passes slugs or improperly segregated parts.

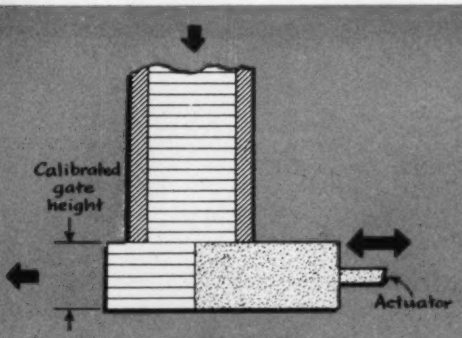
The drum-spider type of escapement such as commonly used on double-end grinding and finishing machines is very close to the basic slide escapement, but its rotary motion requires its mention here. A true drum escapement is the rotary feeder such as used in regulating the flow of bulk materials. Another form of drum escape-



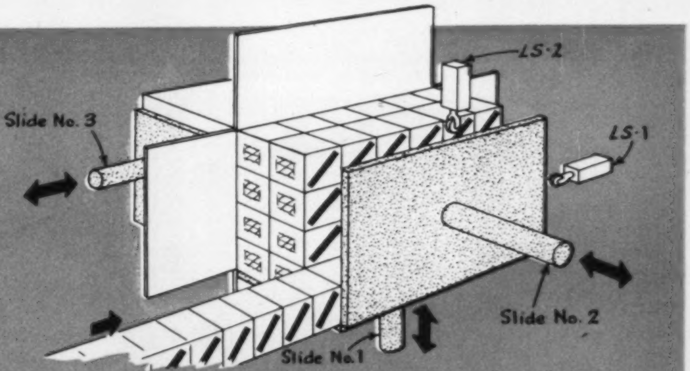
(a)—The familiar turnstile is a device widely applied to industrial uses as well as entertainment and transportation fields.

(b)—This escapement may have continuous or indexing motion to space and time parts for machining, assembly, packaging, etc.

Fig. 3—These drum escapements and closely related types of high speed devices utilize some type of rotary motion in their operation. They can be used whether materials are to flow in a straight line or change direction.



(e)—This slide escapement measures and escapes a specified height of laminations for electrical components. Pressure is applied either continuously or intermittently to the stack in the magazine to minimize errors caused by stamping burrs, variations, dirt, etc.



(f)—Combination of slides controlled by limit switches to escape boxes from a supply track into cartons in a preset pattern. Slide No. 1, actuated by LS 1, elevates row of boxes by one box height. Stack is held up by pawl arrangement while slide drops to pick up next string of boxes. In starting operations, a retractable plate keeps the first stack against Slide No. 2; while operating, two stacks on platform in front of carton eliminate need of the plate. When a stack reaches proper height, Slide No. 2 is actuated by LS 2 and moves all stacks the width of one box. Slide No. 3 removes filled cartons when Slide No. 2 has made the proper number of strokes.

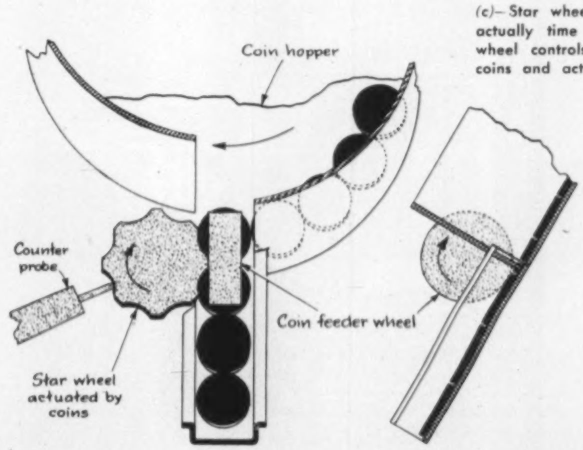
ment is the use of fixtures moving on a conveyor or other transfer means between load and unload stations. This simple form of the drum escapement deserves consideration wherever large items are involved.

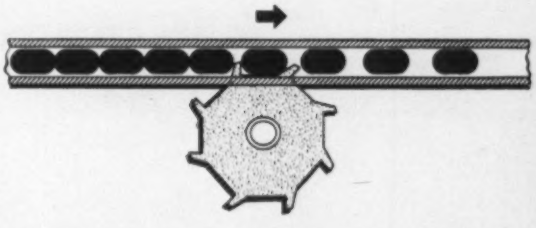
Most of the examples shown are cyclic devices. However, the unit for dispensing liquid to bottles or other containers, *Fig.* 3, is continuous in operation. Bulk materials or discrete units can be escaped in a similar manner. In this illustration the escapement head and the containers to be filled are in continuous motion. Part of the escapement rotation is used for charging the escapement cells and part for discharging the escapement cells into the containers. Cam actuated valves, sliding valve action or many other methods may be used for starting and stopping flow from the reservoir to the escapement and from the escapement to the containers. Cyclic operations can be continuously performed also on vertical drums or even straight-line units comparable to a flying shear which performs a cyclic action on a product having a continuous linear motion.

Many types of high speed escapements have been devised which are close to being drum types. Most of them involve a slicing action in removing one or more parts from a track or tube and are usually continuous in operation. The rotary slicer moves units around an arc; the worm wheel moves units in a straight line parallel to its axis.

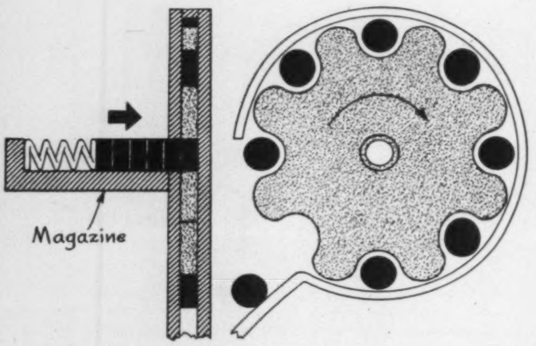
Gate: The most common type of gate escapement, *Fig.* 4, is probably the trap door in the bot-

(c)—Star wheel escapement in this coin counter does not actually time the release of the coins since the feeder wheel controls that. The star wheel does separate the coins and actuate the counter.

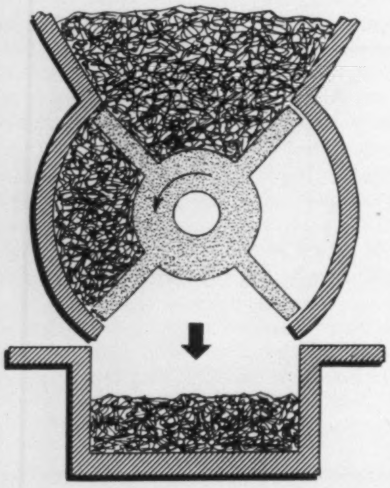




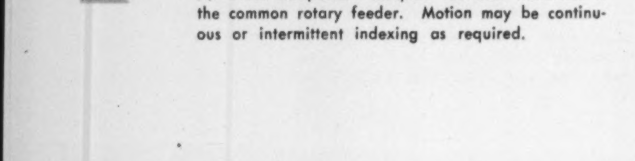
(d)—In feeding items from a conveyor into a processing machine it is frequently very important that the items be escaped to the machine at proper intervals as this star wheel is doing.



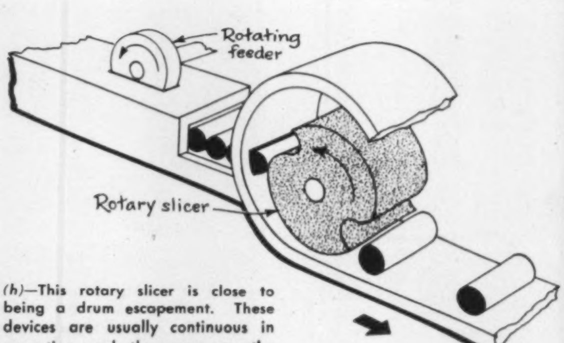
(e)—Magazine-fed, drum-spider type of escapement is very close to the basic slide escapement but uses a rotary motion. Such a device is commonly used on double-end grinding and finishing machines, where spring pressure may be used to force parts from the magazine into openings in the spider.



(f)—Drum escapement adapted for bulk materials is the common rotary feeder. Motion may be continuous or intermittent indexing as required.



(g)—Form of drum escapement of particular use where large objects are involved can be based on fixtures carried by a transfer device.



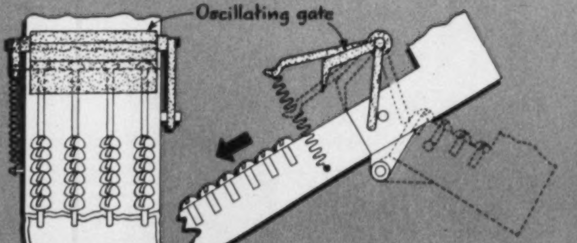
(h)—This rotary slicer is close to being a drum escapement. These devices are usually continuous in operation and the ramp on the drum permits the part to move into the escapement while the drum rotates.

tom of a hopper controlled by a timer, scale, float or other metering device. Another very common use of gates is as flippers or diverters to segregate out of limits units from acceptable units.

Displacement: A liquid escapement which might be classified as a slide, but can be called a displacement type of escapement, *Fig.* 5, is formed from a piston and cylinder fitted with suitable check valves. Standard units of this type are available for very accurate dispensing of liquids and semisolids such as greases.

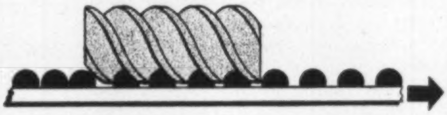
Jaw: Jaw type escapements, *Fig.* 6, are often used in conjunction with machine elements which perform other functions—such as with the punches of punch presses. These escapements can be used where accurate location is required.

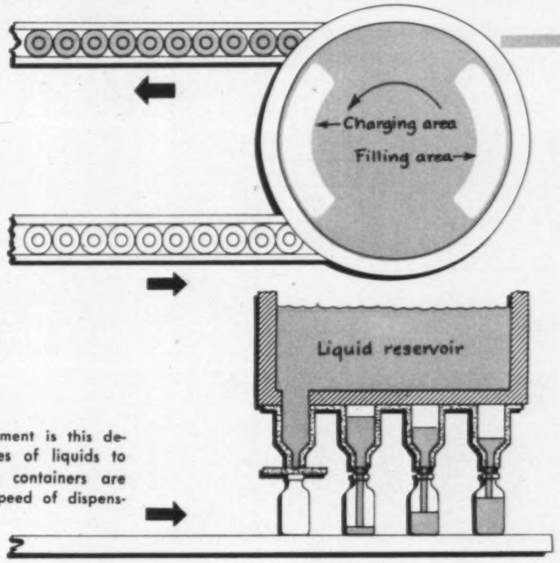
Fig. 4—Many types of gate escapements are used, though the most common is probably the trap door in the bottom of a chute or hopper.



(a)—Multiple track gates such as shown are used to release a number of screws, nails, bearing balls, etc. In this case an oscillating box type hopper opens the escapement each time it moves into position to discharge oriented parts into the track.

(i)—The worm wheel shown is used largely for spacing items prior to dropping them into recesses or tubes which pass the end of the escapement. This is a good method for bearing balls, screws, etc.



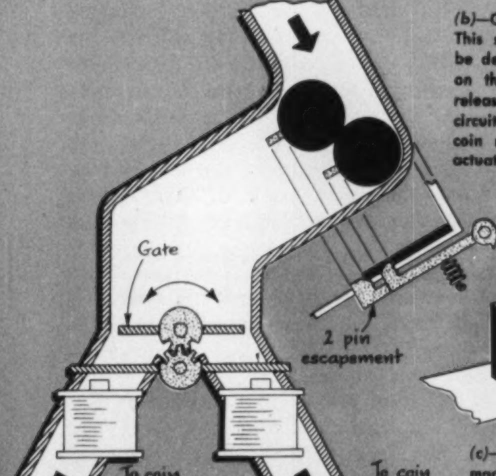


(j)—A continuous form of drum escapement is this device for dispensing measured quantities of liquids to containers. The escapement and the containers are continuously in motion. A very high speed of dispensing may be obtained.

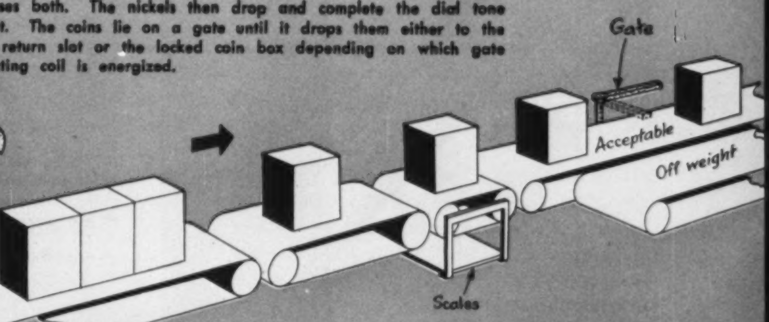
Other Considerations In Applying

Means of actuating these escapements is a distinct area by itself which this article does not attempt to cover. Logically, however, the most positive method is the best, whether it be a direct mechanical connection to another part of the machine or a pneumatic, hydraulic or electric actuator. In any case, the simpler the actuator principle used, the fewer parts and motions involved, the more satisfactory will be the operation. The greatest disadvantage in mechanical actuation is that it can be actuated only by cycling of the complete machine. Many times it is preferable to use an actuator which can be remotely and manually re-cycled should the magazine or feeder jam.

Most machine builders and all hopper and parts-feeder manufacturers supply one or more types of escapements, but do not offer them separately from their other products. This is due to the fact that practically every escapement is tailor-made for a given job, and an escapement alone is seldom required by the customer. However, escapements similar to these basic types are of increasing importance and are sure to be applied more frequently as automatic processing becomes more prevalent.



(b)—Gate escapements are important parts in pay station telephones. This sketch shows the 2-pin device which requires that two nickels be deposited before the dial tone comes on. The first nickel catches on the lower pin until the second nickel trips the other pin and releases both. The nickels then drop and complete the dial tone circuit. The coins lie on a gate until it drops them either to the coin return slot or the locked coin box depending on which gate actuating coil is energized.



(c)—Another type of gate escapement is this one, used on many continuous weighing machines for packaged cereals and foods. Scale sensing of over or underweight units will actuate the gate to divert the unacceptable packages. Such a gate can also be operated by photoelectric cells for detecting color variations or by many other sorting devices.

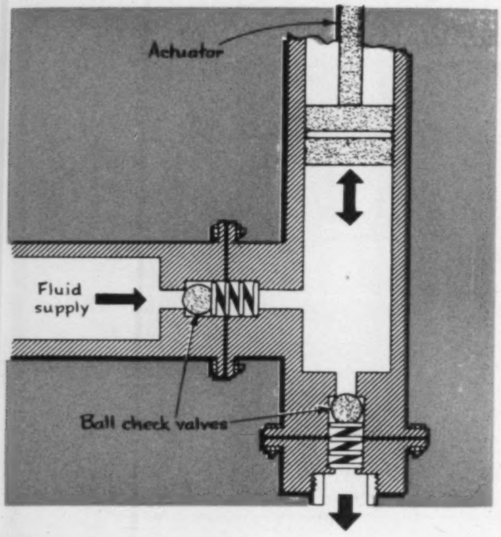
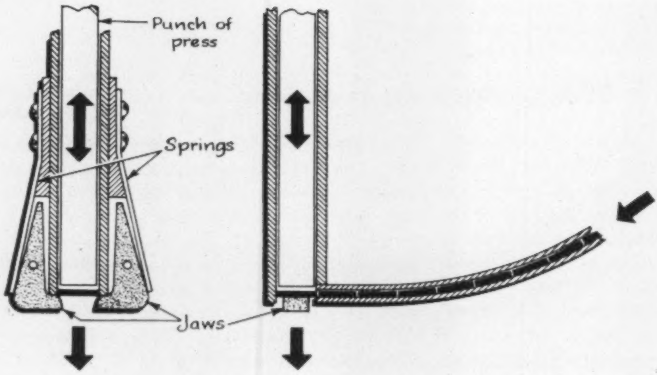
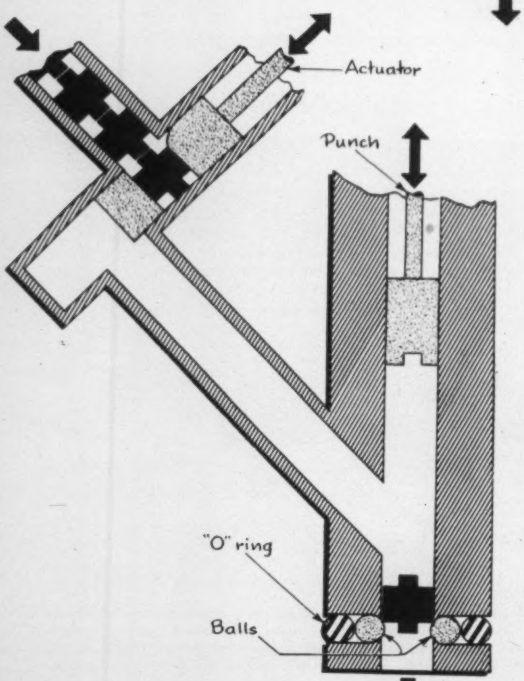

Actuator
Fluid supply
Ball check valves

Fig. 5—This liquid escapement might be classified as a slide, but is here called a displacement type. It is merely a piston and cylinder with two check valves. It fills with a given quantity of liquid on one stroke and dispenses this load on the return stroke. Action is rapid and easily controlled.

Fig. 6—Jaw-type escapements can be used to accurately position and hold parts until other machine elements release them.


Punch of press
Springs
Jaws

(a)—In this application of a jaw-type escapement, the punch of a press removes one part from the track where it is held by spring-loaded jaws. Very accurate location is practical where part dimensions are consistent.


Actuator
Punch
"O" ring
Balls

(b)—Using balls for stop-pins, this jaw-type escapement which holds parts under a punch is applied in conjunction with a slide escapement so that only one part is under the punch at any particular time.

TIMING FUNCTIONS

By JAMES R. WALKER
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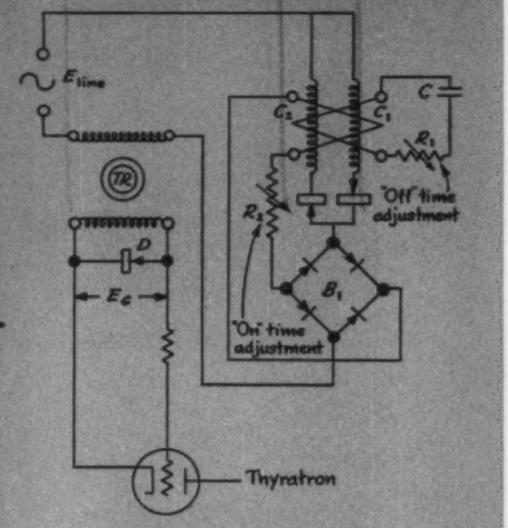
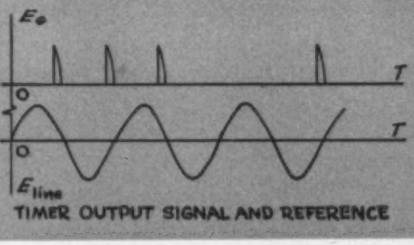
Gemco Electric Co.
Detroit, Mich.

IN PREVIOUS application notes of this series —which have discussed the use of magnetic amplifiers in controlling positioning motors, speed control of motors, and switching functions— some of the natural limitations of magnetic amplifiers have been mentioned. One such limitation is the natural time delay in the response of a magnetic amplifier circuit to quick changes in circuit variables. Ingenious circuits have been designed to exploit this basic tendency by using the magnetic amplifier to obtain a controlled time cycle; three such circuits are discussed in these application notes.



REPEAT CYCLE TIMER



TIMER OUTPUT SIGNAL AND REFERENCE

Repeat Cycle Timer

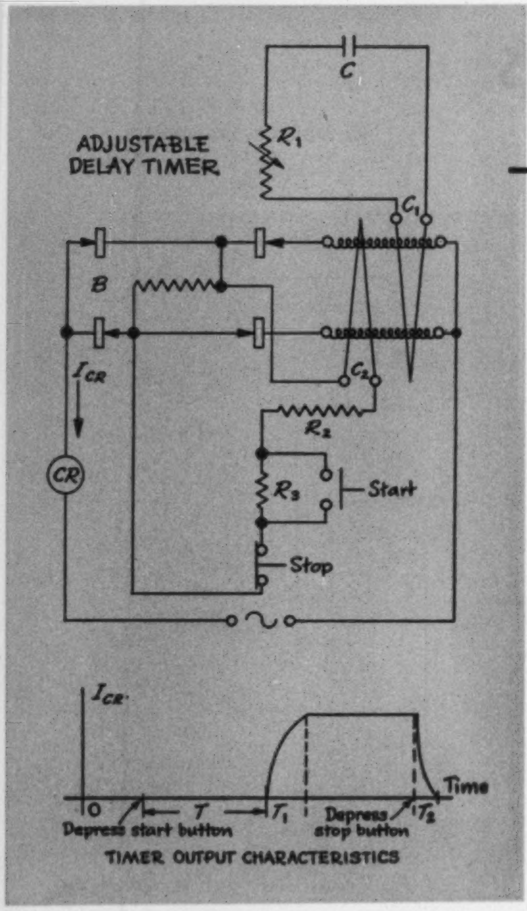
Firing circuits used with sequence controlled welders have, in the past, utilized various types of peaking circuits in combination with vacuum tube timers to furnish control potentials for firing thyratron tubes which in turn were employed to initiate ignitron control tube action. Although vacuum tube timers have been acceptable it has been desirable to replace the vacuum tubes of these welding control circuits with magnetic amplifiers. Such circuits have been devised to accomplish an appropriate timing function and at the same time provide peaked potentials so necessary for accurate control of thyratron switches.

Illustrated is a repeat cycle timer circuit suitable for use with thyratron-ignitron firing circuits. As may be observed, no vacuum tubes are employed in the timer circuits. For the first few cycles after an ac supply potential is applied to the circuit, the secondary control net C_1, including resistance R_1 and condenser C prevents rapid rise of amplifier output current. After an elapsed time determined by the $R_1 \times C$ product and magnetic load to control turns ratio, this secondary circuit current falls to a low magnitude and allows the main core dc flux to become established. Under this condition the cores are nearly saturated, thus increasing the dc potential across the secondary terminals of rectifier B_1 and the exciting current of peaking transformer *TR*. When the potential across the primary of transformer *TR* exceeds only a few volts, it enters the saturated condition and continues in this state until the end of the half period of supply voltage. If the magnetic amplifier remains in the high conduction state as the supply voltage reverses polarity, transformer *TR* will again enter saturation shortly after reversal is complete. Thus two positive and two negative peaks per cycle are derived from this circuit. In order to prevent gas cleanup in the associated thyratron circuit it is necessary to eliminate the negative portion of voltage developed across the secondary of transformer *TR* by means of a rectifier *D*.

A few cycles following the rise of amplifier load current and resulting excitation of transformer *TR* the negative feedback voltage developed across rectifier B_1 will cause a current to rise in control circuit C_2 of sufficient magnitude to cut off further load current flow. Again this current will rise following a several cycle delay according to the mechanism already described.

Dwell time for the *On* pulse is determined by the relative magnitude of forcing resistance R_2 and control to load turns ratio in control circuit C_2. Similarly, the *Off* time is determined by the relative magnitudes of $R_1 \times C$ and control to load turns ratio in control circuit C_1. *On* times of 700 cycles and *Off* times of 1000 cycles are possible with independent variations of both down to 10 cycles.

Adjustable Delay



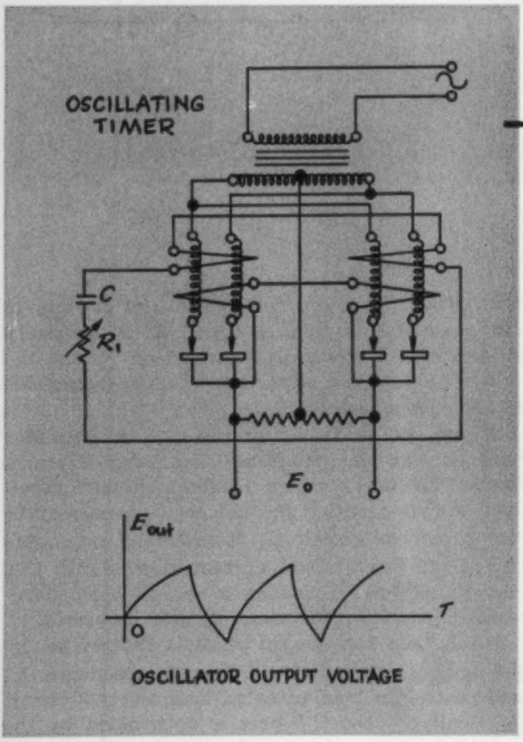
A timer circuit, useful for certain industrial timing applications, employs a doubler-bridge combination amplifier with external positive feedback utilized to render its action bistable or switchlike.

Under conditions of operation just following application of an ac supply, the positive feedback current, derived from load doubler-bridge *B* and lowered by resistance R_2 and R_3, is insufficient for maintenance of the amplifiers in the top state of conduction. However, if the *Start* switch is closed, then the positive feedback current will rise to a value sufficient to retain the amplifier in its top conduction state even if the *Start* switch is later opened. This rise in amplifier load current is not instantaneous however, since the delay characteristics of the secondary control circuit C_1 will not allow the increase until several cycles after the *Start* switch is closed. The exact time of delay of period *T* as shown in the characteristic graph is determined by the time constant $R_1 \times C$ and control to load turns ratio in control circuit C_1.

The maximum and minimum time possible for period *T* is 500 cycles and 10 cycles respectively. Time periods T_1 and T_2 are approximately the same and represent a constant period of six cycles which is independent of the principal period *T*.

Withdrawal of relay *CR* from energization may be effected by depressing the *Stop* switch which reduces the external feedback current to zero and thus lowers the conduction state of the amplifier.

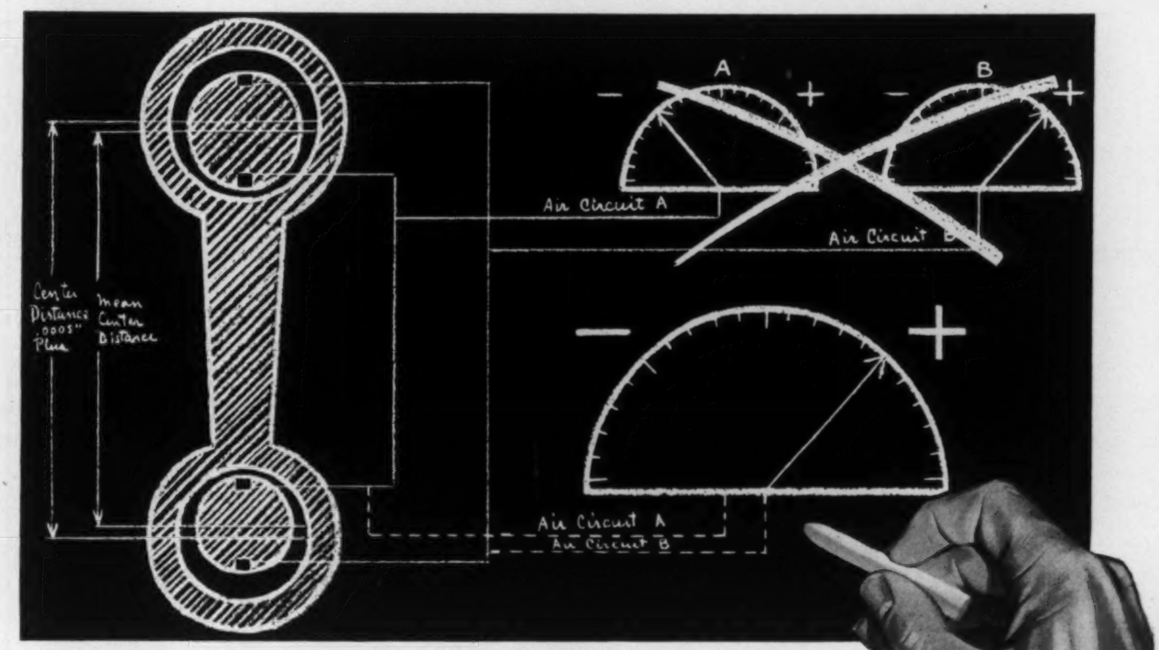
Oscillating Timer



An oscillating timer or vibrator is provided by this circuit in which a push-pull type center tap connected magnetic amplifier is arranged in an external feedback circuit so that each half-cycle of the self-excited oscillation will result in a reversal of potential at the output terminals E_0.

Since the feedback control circuit of each amplifier side is cross connected to the center tapped output resistance it may be visualized that the rise in conduction of one side will result in a fall of conduction in the opposite side and then the reversal of these conditions. The fall time of one side and rise time of the other will be determined by the time constant $R_1 \times C$ and control to load circuit turns ratio of each reactor.

An upper frequency limit of 8 cps may be attained from this type of oscillator with a lower limit of 0.1 cps. The output voltage waveform is illustrated. This type of excitation is suitable for use with polarized type relays or solenoids.



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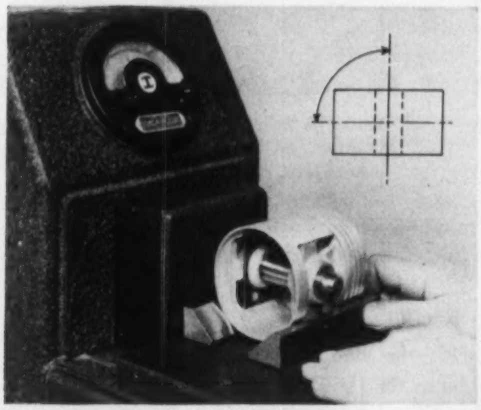
...using a Taft-Peirce Comp-U-Tair*

Gage parts twice as fast — and far more easily — with this exclusive T-P *computing* air gage . . . the Comp-U-tair.

Checking a dimensional relationship like center distance, for example, is greatly simplified. The Comp-U-tair measures, computes, and indicates the result on a *single* indicator with *one* pointer. The Comp-U-tair is a *differential air gage*, in which two air circuits are applied to opposing sides of the differential device. Gaging nozzles are placed so that diameter variations cancel each other and have no effect on true center distance reading. Operator reads just one dial, does no calculating, and has an instant, positive indication for every part — in or out of tolerance, plus exact amount and direction of variation.

Streamline your gaging with the unique Comp-U-tair. Call Taft-Peirce to save time and money throughout your inspection operations. As a starter, write for Air Gage Catalog No. 613.



The Comp-U-tair does many other jobs . . .

One big time-saver is measuring squareness, shown above. Squareness is indicated on one *dial* with *one pointer*. The Taft-Peirce Comp-U-tair figures as it measures, can be designed to check several dimensional relationships *simultaneously*. Number of dials is cut in half . . . inspection is faster, more accurate.

*Patent Pending

THE TAFT-PEIRCE FAMILY...

- Magnetic Chucks
- Precision Gages
- Air Gages
- Grinding Machines
- Lapping Machines
- Tool-Room Specialties

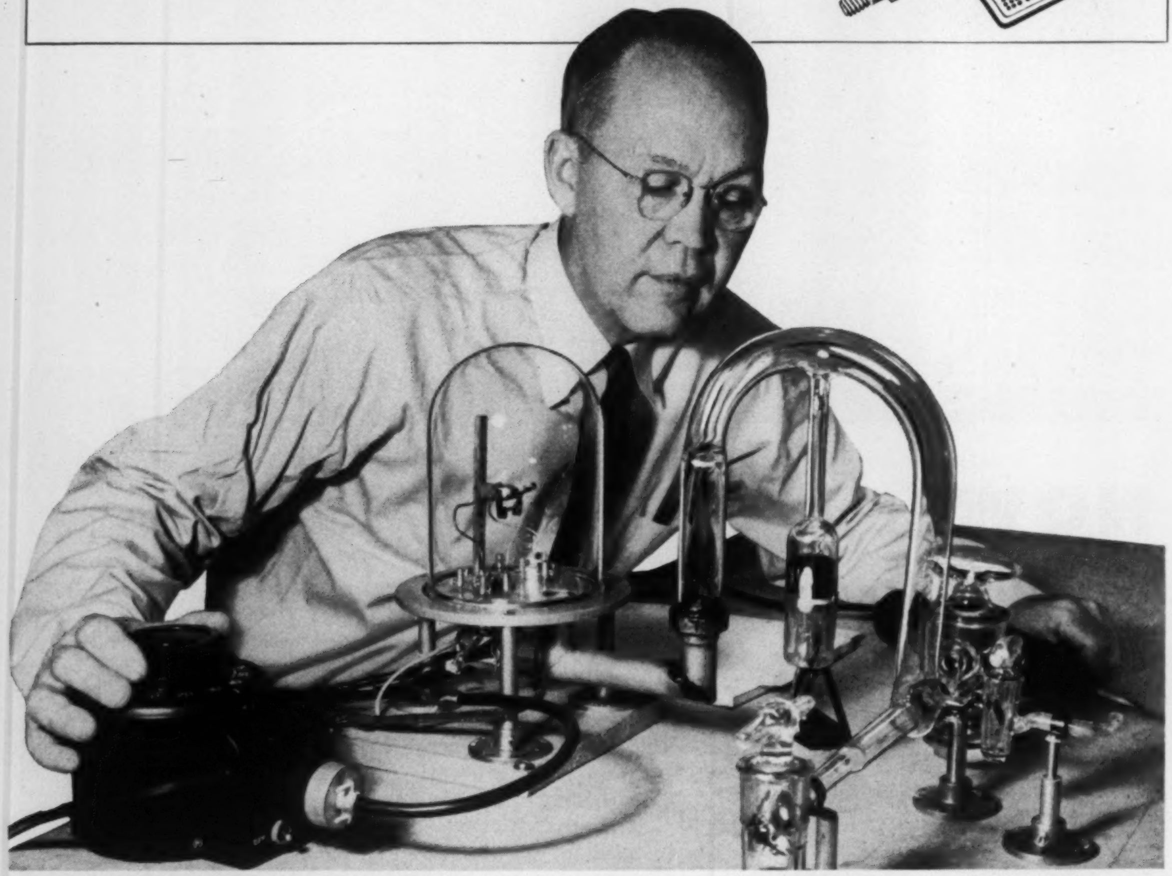
TAKE IT TO TAFT-PEIRCE

TAFT-PEIRCE MANUFACTURING COMPANY
WOONSOCKET, RHODE ISLAND

T-P Means TOP Precision

New technique shapes future of transistors...

LEADS TO THREE MAJOR INVENTIONS



Calvin S. Fuller, Ph.D. in Physical Chemistry from the University of Chicago, is a pioneer in development of the diffusion technique. Here he controls a heating current through a strip of silicon while diffusing into its surface a film of aluminum less than 1/50th of a hair's breadth in thickness.

Transistor makers have a very difficult problem. They must add a mere trace of an "impurity" to a semiconducting metal. But they must add it only in very thin layers, without affecting the bulk of the material.

Bell Laboratories scientists developed an efficient new way to produce such layers. They expose the metal to a hot gas containing the impurity. Atoms bombard the surface and—through a process known as "diffusion"—force their way into the metal to form a microscopic film which can be controlled in thickness to a few millionths of an inch.

The diffusion technique opened the way to three major Bell Laboratories inventions in the semiconductor field: the Bell Solar Battery, Silicon Power Rectifier and the Diffused Base Transistor. Right now the technique is providing a key to many other developments of great promise for telephony. It is another example of how Bell Labs works to improve telephony through fundamental research in materials.

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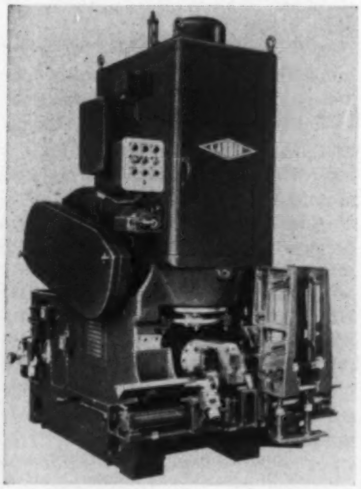


Coupling Tapper

Designed for the high production precision internal threading of oil tubular goods ranging from 1¼-inch external upset tubing to 6-inch outside diameter casing, automatic coupling tapping machine is designated Model 48T. Pneumatically operated and electrically controlled, it features automatic operation with magazine feed. Other features include variable spindle float, a receding chaser tap mechanism to assure threads of a positive and precision taper with infinite settings from ¾-inch to 0 taper per foot, detachable tap heads for wide range coverage with minimum tooling cost, setup ease, lead screw feed, precision worm and worm wheel drive, integral spindle and tap unit for increased rigidity, and rugged compact construction.

Upon starting the machine cycle, a transfer mechanism moves the coupling from the bottom of the magazine along slide plates into the chuck. Correct workpiece positioning in the chuck is assured by operation of the automatic workstop. The grips close and the chuck cylinder moves rearward from the loading position to the tapping area. It then indexes 90 degrees to bring the coupling into tapping position for the first end. By engagement of a lock bolt, the chuck cylinder is positively locked into position for tapping.

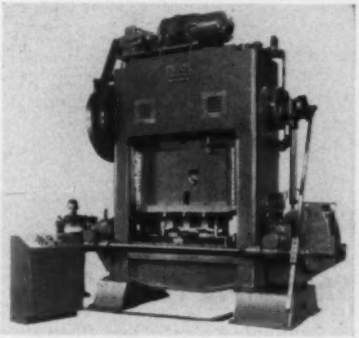
The spindle and tap head unit drops rapidly to perform the threading operation, but is decelerated by a hydrocheck just prior to contacting the coupling. Then the lead screw nuts engage, the tap trip ring contacts the coupling face and coolant is supplied. Simultaneously the tap head enters the workpiece to produce the thread at a pitch rate determined by the machine's lead screw. Tap collapsing occurs as the trip plunger in the tap body is depressed upon contacting an adjustable thread length bar in the collapsing collar. Tap collapsing action opens the lead screw nuts, the coolant flow stops and the spindle is rapidly returned to its uppermost position. With this upward movement, the tap expands. The lock bolt which holds the chuck cylinder in tapping position is disengaged and the cylinder indexed 180 degrees. The lock bolt re-engages and the opposite end of the coupling is then tapped.

Production rates at 100 per cent efficiency range from 96 per hour on 1½-inch line pipe couplings to 17 per hour for 5½-inch casing couplings. Standard merchant, conduit and many special couplings can also be tapped on a high production basis. When straight threads are required, the machine can be set up to enable straight through tapping and single indexing. **Landis Machine Co.,** Waynesboro, Pa.

Circle 401 on Inquiry Card

200-Ton Press

Speeds up to 250 strokes per minute are possible with 200-ton Flexopress. The slide, fitted with four preloaded ball bearing raceways, contributes to the high degree of vertical accuracy. The bottom of the ram is parallel to the bed within 0.0005-inch. Preloading and antifriction construction assure retained accuracy.

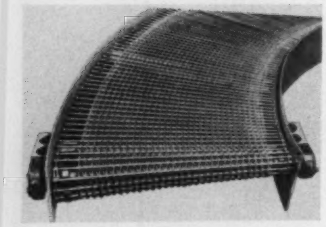


Equipped with air friction type clutch and scrap cutter, the Flexopress has double feed rolls mounted integrally for accurate stock feed. The press has an all steel frame, welded and keyed with four tie rods. Powered by a 25 hp variable speed motor, the machine features console control. **Precision Welder & Flexopress Corp.,** 3520 Ibsen Ave., Cincinnati 9, O.

Circle 402 on Inquiry Card

Power Turns

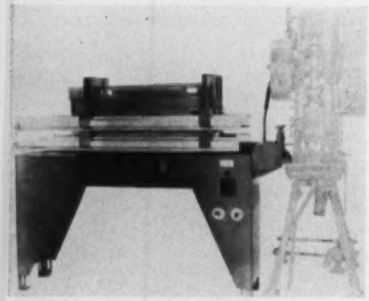
Used wherever it is desired to move light or heavy loads around tight corners or from floor to floor, to provide continuous conveying and convenient delivery of load, Meshlok power turns have a special edge design to prevent stretching and track jumping. The power turns also feature nylon rails for



smoother and quieter running, and extended equipment life.

Versatility of application is afforded, since the channel weave mesh belt can be supplied in widths from 12 to 48 inches, in 24 or 30 inch outside radius, in any degree of turn from 30 to 180 degrees, and with fixed or variable speed up to 100 fpm. **Voss Belting & Specialty Co.,** 5645 N. Ravenswood Ave., Chicago 26, Ill.

Circle 403 on Inquiry Card



Strip Stock Feeder

Laminated plastic and fiber strip stock are automatically fed into any standard blanking press at uniformly controlled temperatures up to 300F by strip stock feeder. The machine is used for blanking plastic and fiber parts with electrical, chemical and mechanical applications, such as resistors, capacitors, switches, relays, terminal blocks, printed boards, gears, etc.

The strip stock, which is loaded into a magazine, rests on a special feed belt synchronized with the press through a crank arm to an indexing roll feed. As the bottom strip leaves the machine, strip above drops into place. Positive butting of the ends reduces partially blanked pieces to a minimum. A single loading of the magazine can produce up to one day's run. An electrical heating system, regulated by thermostatically controlled heating elements, brings the stock to desired blanking temperature and maintains it uniformly. The feeder is lagged to the floor to maintain alignment of the feed tracks with the press die. Leg pads permit adjustment of the feed height to the height of the die feed line. **Technical Design & Development Co. Inc.,** Milford (Devon) Conn.

Circle 404 on Inquiry Card

Timer-Recorder

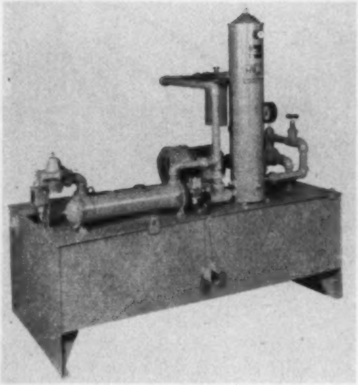
Designed for split-second monitoring of multioperational automatic machinery, timing-recording instrument is called the Monitorecord. Up to 14 or more operating sequences can be simultaneously timed to within 0.01-second and recorded on a strip chart for ready visual reference. The unit can be quickly and simply connected to any electrical control circuit of automatic machinery, enabling production control and maintenance personnel to supervise production by spotting faulty cycles, adjusting sequences for most efficient operation, and preventing slowdowns or shutdowns.

The Monitorecord can be plugged into the electrical control circuit without shutting the machine down, and no other external power supply is required. Start, stop and duration times of the various sequences are timed and recorded on a 5-inch chart of pressure sensitive paper. A time scale of 0.2-second to the inch is marked on both sides of the chart, with space provided between lines for making notations. **Autometrology Div., Sheffield Corp.,** Dayton 1, O.

Circle 405 on Inquiry Card

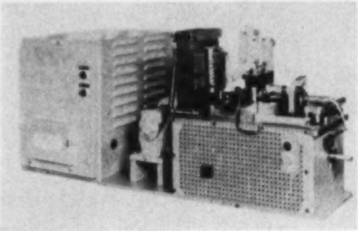
Pumping Units

Developed to lubricate bearing journals on high speed 4Hi foil mills, pressure lubrication pumping unit may be used where it is desired to install a self-contained packaged lubricating system for industrial machinery and mills. The 150-gal pumping unit is designed to deliver 18 gpm at 50 psi to the mill journals. The lubricating oil viscosity is 1200 Saybolt Universal seconds at 100F, and by-pass filtration is employed to remove foreign particles larger than 5 microns.



The unit is equipped with 1018 BTU/min heat exchanger and automatic controls, to maintain constant temperature and to prevent build-up of abnormally high pressure. **Cardwell Machine Co.,** Richmond 11, Va.

Circle 406 on Inquiry Card



Wire Cloth Welder

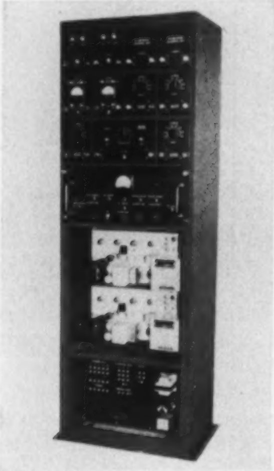
Designed for forming and welding cylindrical screens of wire cloth, automatic machine is used in the automotive industry for the mass production of gas line filters. Machine is also for use in the aviation industry for the making of fuel line strainers and screens, and in the electronics industry for forming and welding vacuum tube and microwave parts.

In operation, wire cloth is fed to the machine from a reel, cut to size, wrapped on an arbor, welded, then ejected. This complete process is automatic, and nominal production rate is 3000 parts per hour. For fuel filters, 120 x 108 mesh of monel metal wire cloth, 0.687-inch wide, formed on a 0.192-inch arbor, is used. With appropriate tooling, the machine forms other cylindrical parts in a wide range of diameters and in lengths to 0.750-inch. Machine is supplied complete with all power supply components and controls. **Federal Tool & Engineering Co.,** 1384 Pompton Ave., Cedar Grove 1, N.J.

Circle 407 on Inquiry Card

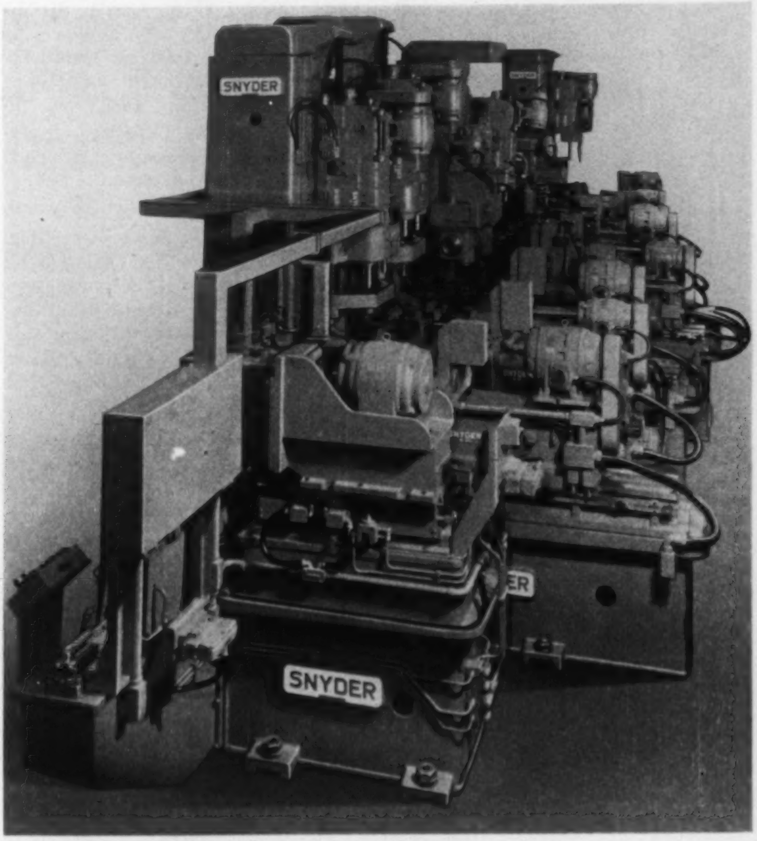
Measuring Systems

Packaged protective and measuring systems are designed for use in pipe lines, the chemical industry and test facilities. The systems include plug-in electronic units for temperature protection, pressure protection, vibration protection, pressure measurement and pressure telemetering. The plug-in unitized type construction allows the achievement of compatibility between system and installation. The various measuring and protective units are housed in a master cabinet that contains the entire protective and measurement system.



The system is designed so that only low level sensing elements are located in hazardous areas. Interconnections by means of cable are used throughout. Other features include: Double-pole contacts for alarm and shutdown functions, all electronic fast-acting circuitry, explosion proof and fail-safe construction. **Indikon Co.,** 76 Coolidge Hill Rd., Watertown 72, Mass.

Circle 408 on Inquiry Card



Oil Pump Body Transfer Machine

A parts distribution system that feeds finish-machined and tested parts to each of three conventional precision boring machines is the feature of 100 ft long, 84-station segmented transfer machine. Unit machines, washes, and air tests cast iron automotive oil pump bodies at a rate of 103 pieces per hour at 75 per cent efficiency. Parts are fed to each boring machine according to its demand.

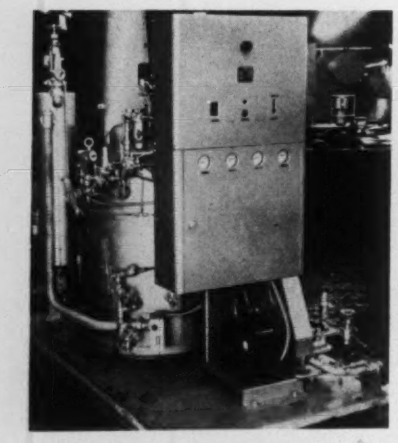
A variety of drilling, milling, reaming, tapping, trepanning, boring, spotfacing, countersinking and chamfering operations is performed in the first 12 segments and 43 stations of the machine. Parts are washed in segment 13 which has eight stations, and then are air tested in segment 14 which has two stations. Any parts which do not pass the air test are automatically rejected from the transfer line. Following the air test, the parts are fed through three segments having a total of 31 stations. Each segment has a parts distributor mechanism for a precision boring machine. Two parts are stored ahead of each machine. A part is automatically directed to any of the machines where less than two parts are stored.

New machine has individual segments, each having individual bases and control panels to simplify machine construction, maintenance and part design change problems. **Snyder Tool & Engineering Co.,** 3400 E. Lafayette Ave., Detroit 7, Mich.

Circle 409 on Inquiry Card

Steam Generator

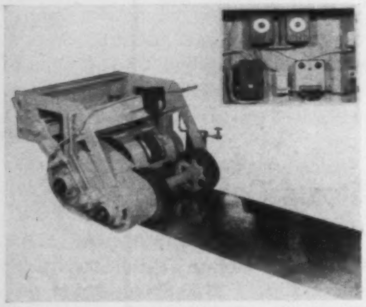
Rated at 60 bhp, Model 4615 Modulatic steam generator produces 400 to 1750 lb of steam per hour, from 60-degree feed water at 75 to 300 lb steam pressure. The generator develops 200 lb steam pressure in two minutes from cold water. Automatic controls cause the steam generator to cycle *On* and *Off* and change the volume of steam produced to meet a changing steam demand,



without making any manual adjustment. The servo-water-bypass control meters the fuel, feed water and combustion air, so that the generator produces steam at about 80 per cent efficiency at all levels of output. The working steam pressure may be changed from 75 to 300 psi by turning one control.

Safety controls on the generator include a steam temperature limit control, a low water cutout, electric eye, safety valve, motor overload cutout, atomizing steam or air combustion switch cutout and an excessive water pressure relief valve. The unit is a complete package which includes a 3 hp electric motor, blower, feed water pump, steam separator, fuel pump, panel mounted controls — all mounted on a steel base. **Vapor Heating Corp.,** Dept. PR-57, 80 E. Jackson Blvd., Chicago 4, Ill.

Circle 410 on Inquiry Card



Galvanized Sheet Printer

Electronically controlled machine, No. 247, is designed for the printing of individual lengths of sheet stock. It offers controlled selectivity of the particular sheets to be printed, i.e., the printing of every second, third, fourth, all the way up to every 400th sheet, as desired. It also controls the linear placement of the markings on each sheet. Information such as inspectors' marks, coding, trademarks, heat numbers, etc. is printed as fast as the material is fed.

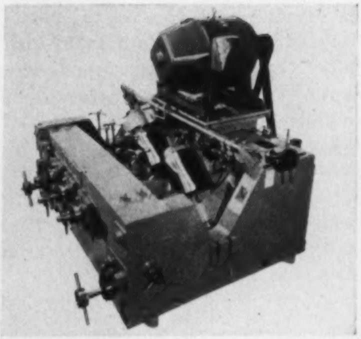
In operation, the machine prints in co-ordination with the stock passing beneath the drive tires, producing a clear, legible impression with every revolution of the automatically actuated printing die. The printer is mounted above a conveyor belt. A sheet of stock, traveling along the conveyor table, interrupts a beam of light between a vertically opposed photoelectric cell and light source mounted above and below the conveyor table. Interruption of the light beam relays an electrical impulse, actuating an automatic counter which has been preset to the desired number of sheets that will pass through the unit before printing. This count is determined with a selector switch in the main control panel. As the exact sheet interrupts the light beam, a timing device is actuated.

The timing device controls the delay in starting the revolution of the printing cylinder, thus controlling the linear placement of the mark on the sheet. Once the printing is accomplished, the printing cylinder comes to a complete stop to await the next cycle. Inking of the printing plates is accomplished automatically from an integral ink fountain. **Jas. H. Matthews & Co.,** 3945 Forbes St., Pittsburgh 13, Pa.

Circle 411 on Inquiry Card

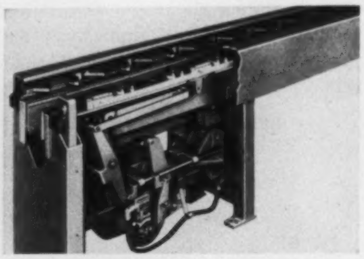
Pipe Straightener

Used for high speed straightening of steel or nonferrous pipe and tubes, machine is designated Model 2JM Special. The unit operates at production speeds up to 1000 fpm and faster, depending upon the application. Incorporating the Sutton five-roll principle, rolls are positioned for a horizontal pass line. A pressure roll is located between two sets of opposed rolls with each set having one opposed driven roll and one idler roll. Because only one roll of each pair of cross rolls is driven, wear is reduced and roll life lengthened. While guides ordinarily are used for safety, the machine can operate with or without guides.



Longitudinal positioning of pressure rolls together with angular adjustment of all five rolls makes accurate end-to-end straightening possible over a wide range of sizes. The horizontal pass line permits scale to fall away into a disposal pit for faster, cleaner operation. **Sutton Engineering Co.,** First National Bank Bldg., Pittsburgh 22, Pa.

Circle 412 on Inquiry Card



In-Line Transfer Table

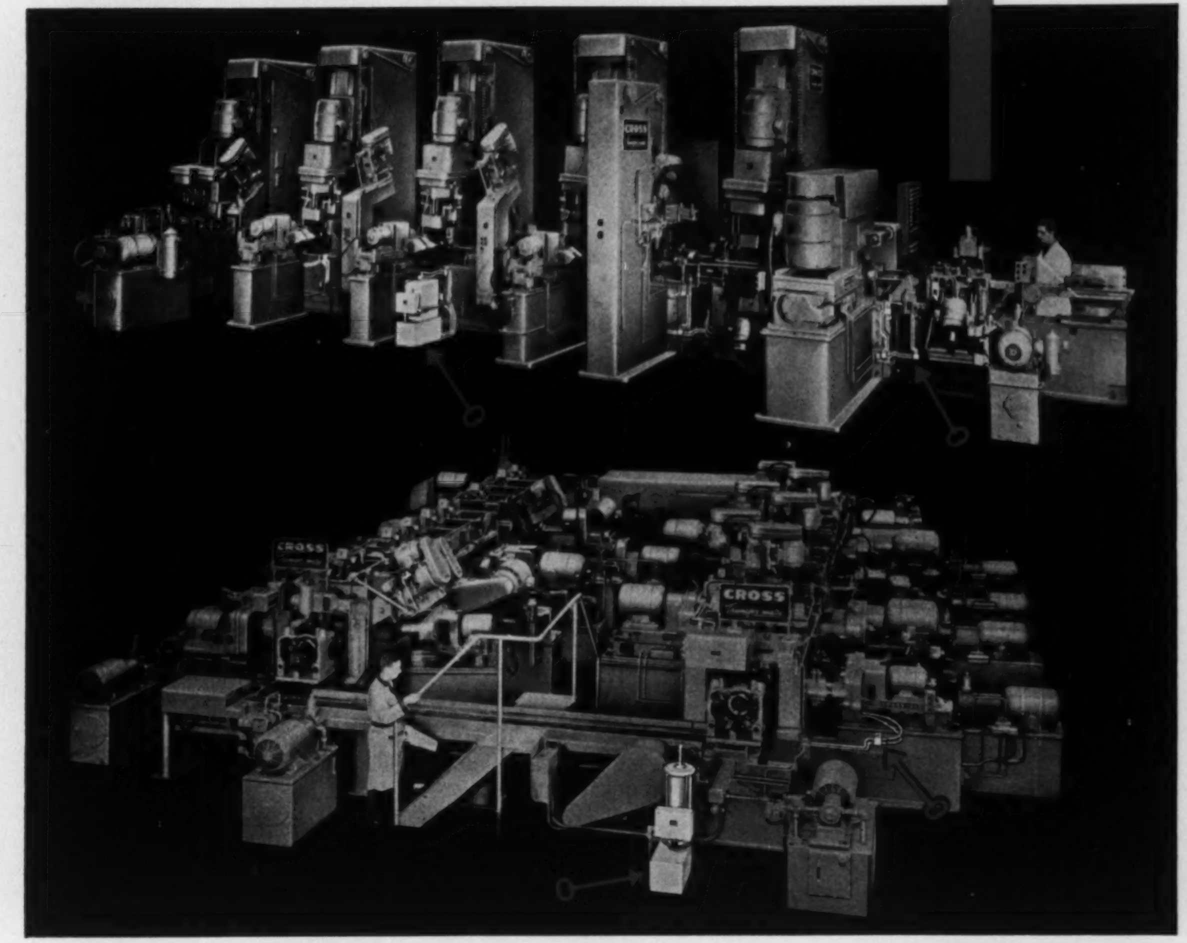
Piece parts can be transferred from station to station for automatic or manual operations by in-line transfer table. The fixtureless table can be adapted to multiple, consecutive operations and will handle 6400 pieces per hour.

Designed for piece parts which have a flat surface on which to slide along a track from station to station, the table will cam lock piece parts at each station within 0.005-inch tolerance without auxiliary locating devices. When tolerance is less than 0.005-inch, a shot pin or locating lug on the piece part can be utilized.

The base support of the transfer table contains an intermittent drive unit and may be located at either end or in the middle of the table to suit production require-

Lubrication by Farval is automatic, too, on these Cross Transfer-matics

FARVAL—
Studies in
Centralized
Lubrication
No. 194



● Automation is the soul of Cross Transfer-matic machine tools. They do as many as 73 machining operations one after another on complex parts, delivering more than 100 pieces per hour.

Vital to continuous operation of these machines is the lubrication system. It, too, is automatic. It is Farval. With Farval there is no need to stop a machine for lubrication of even its most inaccessible bearings. And Farval ensures that every bearing receives the proper amount of oil or grease as often as needed.

More and more, machine designers, engineers, and production men are employing Farval to protect the large investments represented by automated production lines. Farval's own sales engineers are available and eager to work with industry to meet any and all problems related to centralized lubrication. For Bulletin 26-R and details of our engineering service, write The Farval Corporation, 3265 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm and Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

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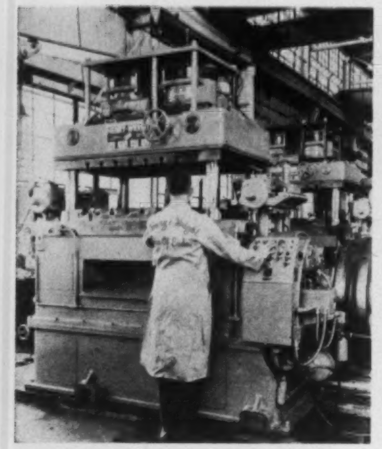
Wherever you can see these Farval manifolds, dual lubricant lines, and central pumping station, you know a machine is being properly lubricated.

FARVAL
CENTRALIZED SYSTEMS OF LUBRICATION

Circle 584 on Inquiry Card

ments. In-line construction allows operators to work from both sides of the table, and machines or equipment are readily accessible from either side for adjustment or tool replacement. Index distance can be varied from 3 to 9 inches and index time from 0.25 to 0.7 second. Since the inertia loads are low, fast indexing can be accomplished quietly and efficiently with a total cycle time from 0.56-second. The dwell time is adjustable. The tables are available in lengths from 5 to 12 ft; longer models are available if required. **Dixon Automatic Tool Inc.,** 2300 23rd Ave., Rockford, Ill.

Circle 413 on Inquiry Card

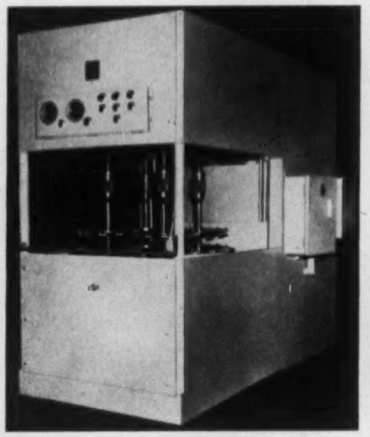


Double Crank Die Units

Designed to produce large size stampings requiring large bed areas but not necessarily heavy tonnage capacities, automatic double crank dieing machines also provide the strength necessary for turning out parts by progressive stamping methods when eccentric loading demands extra rigidity. Machines equipped with progressive dies make it possible to combine complex stamping and forming operations into one progressive production sequence.

In operation, coil or sheet metal is fed through roll feeds to a series of die stations where piercing, blanking, forming and other operations are accomplished with each stroke. After the first part is ejected, each stroke of the machine produces a finished product. In the double crank machine, pressure is applied by two crankshaft connections located in the base, providing a more even distribution of force over a longer bed area. The roll feed incorporates box gearing so that when the roller is raised the stock gearing remains meshed. Pneumatic cylinders with adjustable air pressure provide tension on the upper rolls. **Henry & Wright Div., Emhart Mfg. Co.,** 541 Windsor St., Hartford 1, Conn.

Circle 414 on Inquiry Card

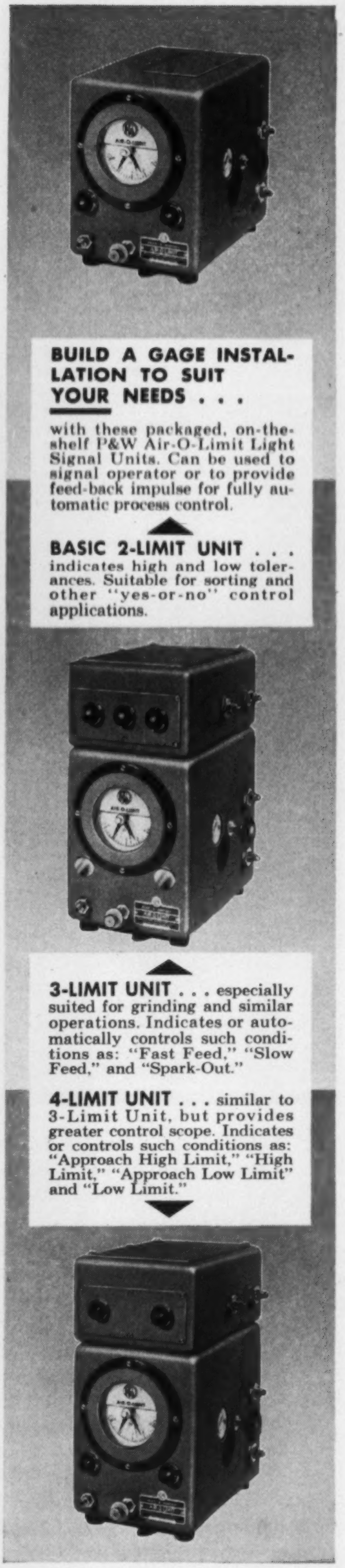


Finishing Machine

Spin-Finish is the name given to mechanical process developed for the finishing of brass, zinc base and aluminum die cast parts in one, automatically timed operation, preparatory to plating. The equipment, using a dry compound, produces on a multiple mounting of parts, surfaces and lustre equal to or better than that of older methods.

Fixtures are mounted on four double-action, revolving spindles. An automatically timed cycle immerses parts in the compound. The design of the fixtures permits simultaneous locking and unlocking of parts with a single turn of a cam. Dust-free and fume-free, Spin-Finish eliminates the use of blowers and ventilating systems. The principle of the new machine combined with the newly developed compound permits finishing in a single operation parts unusual in shape, which, under conventional methods, are difficult to process or require several separate operations, **Grav-i-Flo Corp.,** Sturgis, Mich.

Circle 415 on Inquiry Card



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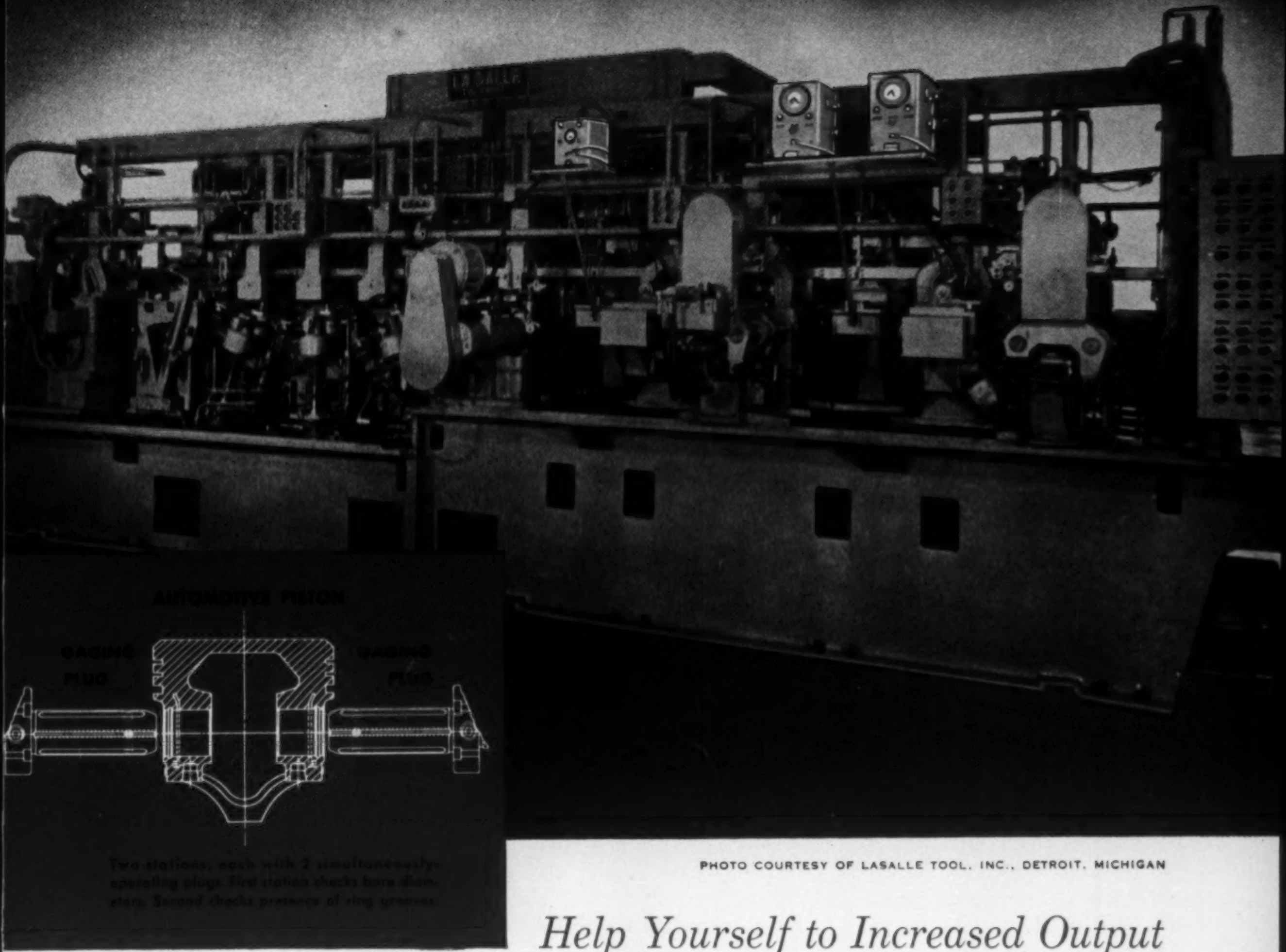
with these packaged, on-the-shelf P&W Air-O-Limit Light Signal Units. Can be used to signal operator or to provide feed-back impulse for fully automatic process control.

BASIC 2-LIMIT UNIT . . . indicates high and low tolerances. Suitable for sorting and other "yes-or-no" control applications.

3-LIMIT UNIT . . . especially suited for grinding and similar operations. Indicates or automatically controls such conditions as: "Fast Feed," "Slow Feed," and "Spark-Out."

4-LIMIT UNIT . . . similar to 3-Limit Unit, but provides greater control scope. Indicates or controls such conditions as: "Approach High Limit," "High Limit," "Approach Low Limit" and "Low Limit."



Two stations, each with 2 simultaneously-operating plugs. First station checks bore diameters. Second checks presence of ring grooves.

PHOTO COURTESY OF LASALLE TOOL, INC., DETROIT, MICHIGAN

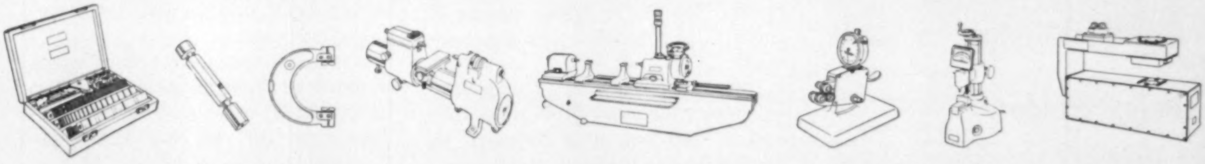
Help Yourself to Increased Output

WITH PRATT & WHITNEY STANDARD, ON-THE-SHELF GAGE CONTROL UNITS

INCREASED OUTPUT RATES, INSURED ACCURACY, REDUCED REJECT LOSSES . . . are the benefits you get with On-Machine Automatic or Automation Gaging! And now, these standard P&W Packaged Units . . . with appropriate tooling . . . can provide an installation tailored to your needs *without* the expense or delays required to engineer and construct special controls.

For example, these P&W Packaged Units made it easy to provide automatic on-machine gaging for this special, high-speed automotive piston machine produced by LaSalle Tool, Inc. Two P&W Air-O-Limit Carbide Gage Plugs are arranged to check the ID of both wrist pin bores on the pistons automatically. Lights on the P&W Control Units signal the operator if tolerances are exceeded. A second set of gage plugs similarly checks bores for the presence of snap ring grooves. If desired, control units can be arranged to shut down the machine automatically when an imperfect part is detected. Whatever *your* requirements, P&W can supply gaging equipment exactly right for the job.

For complete information, write to Pratt & Whitney Company, Inc., 35 Charter Oak Boulevard, West Hartford, Connecticut.



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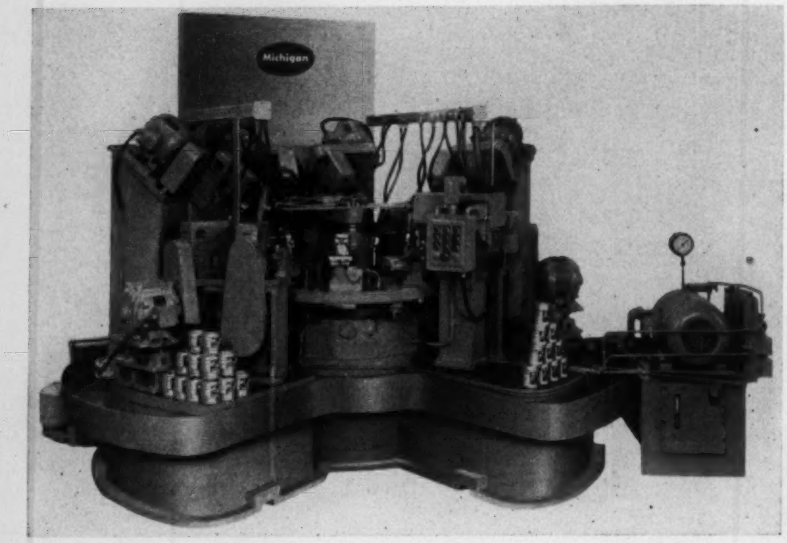


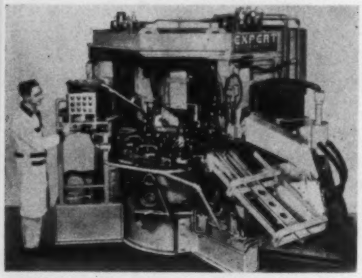
Multistation Piston Processor

New eight-station, horizontal and angular dial type machine features hydraulic index table and individual, automatic indexing fixtures for the processing of pistons. The machine, which drills 1200 pistons per hour, performs ten separate operations on each piston during each complete cycle. It finish drills four angular holes, and finish drills six horizontal smoke holes.

Attached to the 42-inch hydraulic index table is a mounting plate, 60 inches in diameter, to facilitate the mounting of the indexing fixtures. Automatic indexing fixtures make it possible to drill the odd angular holes, as well as the horizontal smoke holes on one machine. Completed pistons are ejected automatically at the eighth station.

The machine features hydraulic power clamping of fixtures and fully automatic clamping and cycle control from station to station, and automatic lubrication throughout. **Michigan Drill Head Co.,** P. O. Box 4643, Detroit 34, Mich.

Circle 416 on Inquiry Card



Index Welder

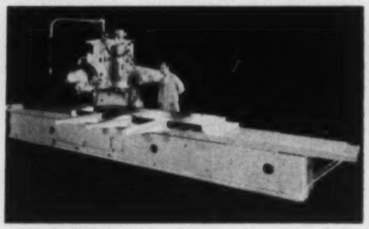
Designed for accurately positioning and welding nuts or brackets to surfaces of production parts, automated machine is a seven-station rotary index projection welder. The machine features a start and stop cam drive mechanism that controls index and weld sequences, bowl feeders equipped with hopper feed tracks, a transfer device for delivering weld nuts to the projection welding guns, and a mechanism for projection welding brackets to production parts. An air powered unloader mechanism automatically removes the finish welded assemblies from the machine and deposits them on a conveyor. The motor driven welder is electrically controlled and air operated.

Illustrated model projection welds two tee nuts, three weld nuts and a steering stop bracket to automotive suspension arm assemblies at a rate of 400 per hour. Power for the cam drive is supplied by a $1\frac{1}{2}$ hp electric motor. Welding current is supplied by four 65 kva and two 100 kva transformers. **Expert Welding Machine Co.,** 17144 Mt. Elliott Ave., Detroit 12, Mich.

Circle 417 on Inquiry Card

Air-Frame Mill

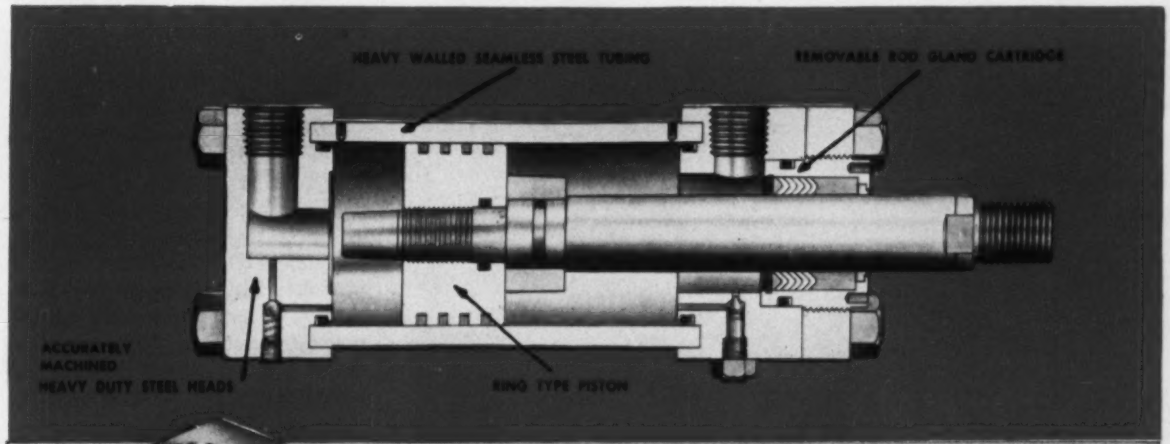
Designed for fast, high precision machining of variable and complex shapes, hydraulic planer type mill speeds the machining of air frame parts. The machine can be furnished in heights of 30, 36, and 42 inches, widths of 30 or 36 inches, and with stroke lengths of 6, 8, or 10 ft. The hydraulic and electrical equipment are interlocked for maximum operator efficiency and safety protection for operator and work.

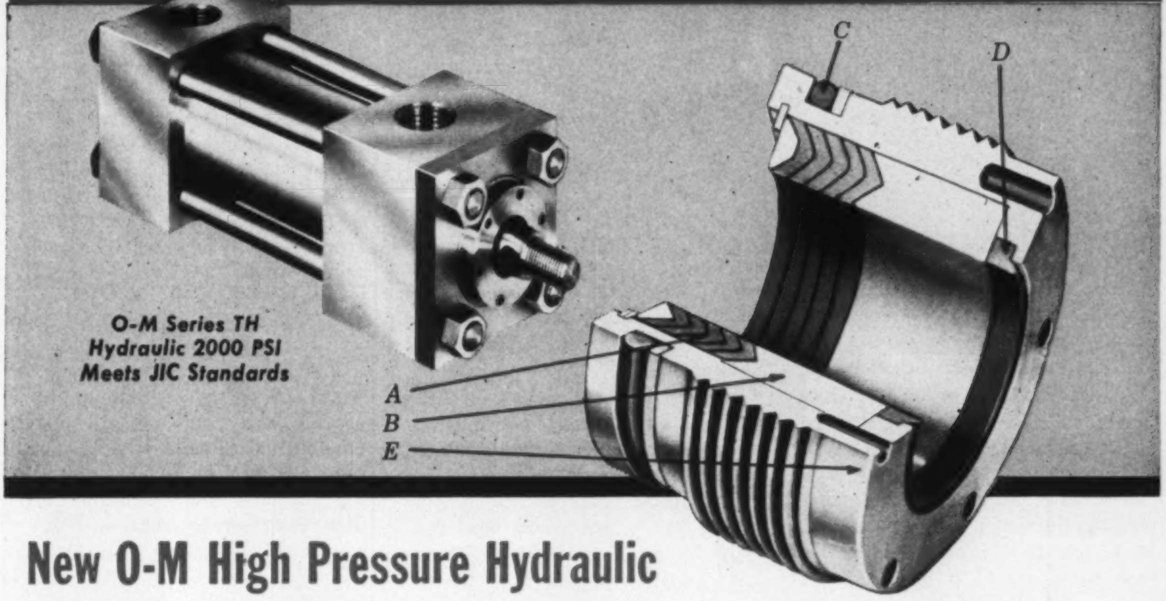


Both bed and table ways are designed especially for tracer milling control. The ways are square with hold down for vertical adjustment and a narrow guide on the column side. The full rated stroke of the machine is available for all lengths. As the maximum stylus tool adjustment is also the rated width of the machine, a subplate or extension bars are required to carry the master to machine a workpiece as wide as the table. Hydraulic power is provided by a $7\frac{1}{2}$ hp unit employing tandem mounted pumps. One is used for cross and longitudinal movement and one used for vertical movement. The power unit also includes a heat exchanger with automatic temperature control to maintain constant oil viscosity for accurate duplication. A completely separate and independent 1 hp pumping unit is used to counterbalance the duplicating head and is also used for table lubrication.

A three-dimensional tracer valve is mounted on adjustable slides for longitudinal, cross and vertical adjustments for varying the relationship between cutter and stylus. An additional tracer valve, arranged with a four-position turret stop, is provided for variable depth control for 360-degree contour operations. **Rockford Machine Tool Co.,** Dept. F, 2500 Kishwaukee St., Rockford, Ill.

Circle 418 on Inquiry Card


HEAVY WALLED SEAMLESS STEEL TUBING
REMOVABLE ROD GLAND CARTRIDGE
ACCURATELY MACHINED HEAVY DUTY STEEL HEADS
RING TYPE PISTON



O-M Series TH Hydraulic 2000 PSI Meets JIC Standards

New O-M High Pressure Hydraulic Cylinder equipped with Removable Rod Gland Cartridge

The O-M-engineered removable Rod Gland Cartridge, exclusive with the O-M Series TH Hydraulic Cylinders, incorporates all the features essential to peak performance and minimum maintenance. It is constructed with a heavy wall steel shell threaded for quick, easy removal, and accurately piloted in rod head to assure perfect alignment. In most applications cartridge can be removed easily without removing mounts or the rod nuts. You simply loosen and remove with a spanner wrench.

A ***Rod Packing***—Vee type, non-adjustable, self-compensating, rod gland packing provides multiple lip seal with excellent pressure sensitivity and long life.

B ***Rod Bearing***—Extra long, bronze rod bearing provides large bearing surface located well forward for maximum support of piston rod.

C ***Cartridge "O" Ring Seal***—With leather back-up washer provides positive seal and acts as friction lock to retain cartridge.

D ***Rod Wiper***—Homogeneous lip type located well forward to prevent accumulation of dirt in pocket. Metallic scraper (AN approved) available and interchangeable with wiper.

E ***Pilot***—O.D. of cartridge serves as pilot for cylinders mounted on rod end.

O-M Series TH High Pressure Hydraulic (oil) Cylinders—conservatively rated at 2000 P.S.I.—are available in bore sizes 1½ to 8-inch inclusive. Descriptive drawings of cylinder, mounts, mounting brackets and capacity chart are included in the new O-M Bulletin 105. Mail coupon for your FREE copy today.

ENGINEERING SERVICE—consult an Ortman-Miller representative regarding your hydraulic or pneumatic problems. His broad experience with standard and special cylinder applications is available to you without obligation. Use convenient coupon.

ORTMAN-MILLER
MACHINE COMPANY
25 143rd Street, Hammond, Indiana

☐ Have representative call. ☐ Send Bulletin 105.

Name__________ Position__________
Company__________
Address__________
City__________ Zone_____ State__________

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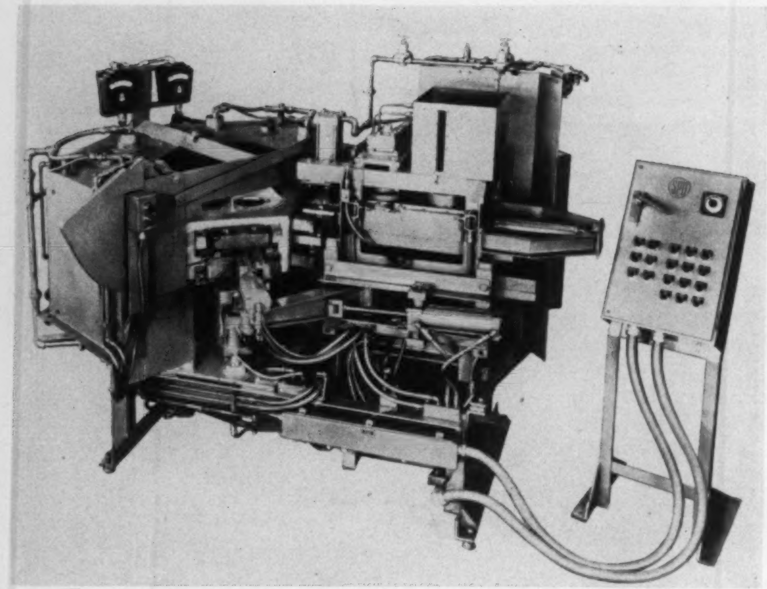
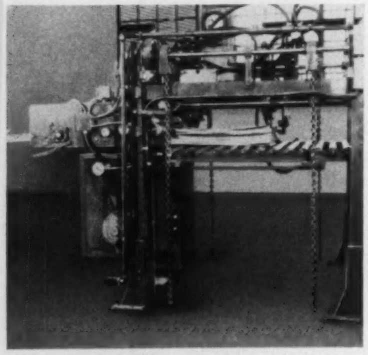


Rotary Machine for Hollow Core Production

New multistation, rotary type machine is designed to mass produce precision hollow cores. New unit, designated Model SC-10-R, has been developed to provide production foundries with a high speed automatic machine capable of producing accurate ready-to-use hollow cores in large volume. Its complete cycle is 15 seconds or less. Model SC-10-R accommodates six core boxes up to 6 by 10 by 12 inches. All operations, except for actual removal of the finished cores, are automatically controlled by precision valves and electrical equipment.

In addition, the machine features an automatic thermostatically controlled oven and insulated oven sealing doors to assure constant and accurate curing temperatures for blown cores. **Spo Inc.**, 6570 Grand Division Ave., Cleveland 25, O.

Circle 419 on Inquiry Card



Warped Sheet Feeder

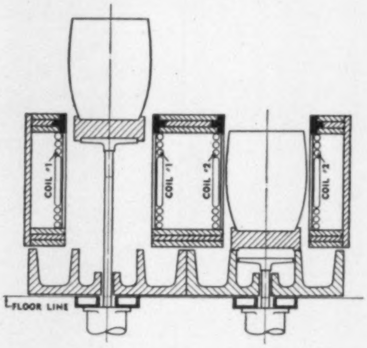
Designed particularly to feed bookbinders' board to calenders following the process in which moisture is squeezed from newly filtered fiberboard mats, device feeds up to 85 sheets per minute and is applicable to handling other irregular surfaced materials. In operation, stacks of material are placed on the elevator platform of the machine and the elevator raised by pushbutton control to the feeding mechanisms. From there sheets feed automatically to processing.

Suction cups separate and forward the top sheet from the pile, with a blast of air assisting from the rear. Forwarded sheets are fed between drop rollers and discharged onto a ribbon conveyor which carries them to the machine being fed. Should more than one sheet feed at a time, a caliper device stops the machine for separation or removal of the doubles. **Dexter Folder Co.**, 219 E. 44th St., New York 17, N.Y.

Circle 420 on Inquiry Card

Push-Out Furnace

Operated on the removable crucible principle, push-out furnace consists of one furnace with two melting positions. The moment the charge in one position is ready for pouring, power is transferred to the second melting position. A hydraulic cylinder raises the crucible of molten metal from the first position so it can be carried to the molds for pouring. This operation saves two or three minutes in transfer time per crucible.



The furnace is short and compact, and occupies minimum floor space. The coils do not move, eliminating flexible leads or contacts, as well as a hoist for raising the coil. **Inductotherm Corp.**, 412 Illinois Ave., Delanco, N.J.

Circle 421 on Inquiry Card

Tape Regeneration Unit

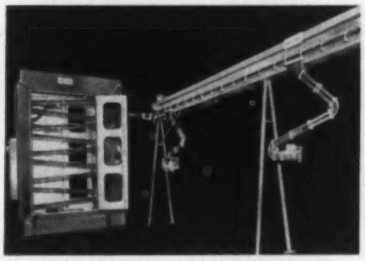
Used for wire transmission, computer input, tape-to-card converters, address plate embossing machines, recording instruments and other tape-operated equipment where one long tape accelerates the processing of data, punched paper tape regeneration unit consists of a motorized tape punch that is cable-connected to a motorized tape reader. The unit duplicates five, six, seven or eight-channel tape at the rate of 20 codes a second, or 1200 codes per minute, producing a composite tape.

To prepare a composite tape on the tape regeneration unit, the operator feeds individual tapes, which may have been produced on Flexowriters or other types of tape producing devices, into the reader. Simultaneously the codes are duplicated in the punch, producing a composite tape of all the informa-

tion recorded in the individual tapes.

An application of the unit is in sales order writing, where, utilizing one or more Flexowriter automatic writing machines, individual byproduct tapes are created automatically as the others are written. These tapes, varying in length, contain all or selected information as desired. To speed up the processing of data, a composite tape combining the recorded information into one long tape is prepared on the tape regeneration unit. When complete, the composite tape is fed into the tape-to-card converter which produces tabulating cards, or it is transmitted over existing communications equipment to the plant designated to fill the order. **Commercial Controls Corp.,** One Leighton Ave., Rochester, N.Y.

Circle 422 on Inquiry Card

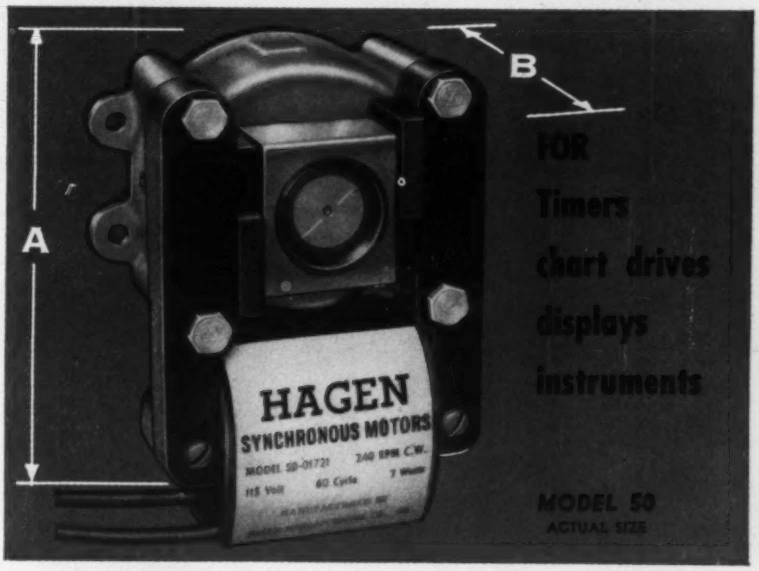


Distribution Systems

Automatic manufacturing, without synchronization and without altering standard machine tools, is possible by linking those tools into an integrated line by a demand feed distribution system. The system consists of conventional machine tools, distributing equipment and automatic gaging and inspection equipment.

Progress of parts through such an integrated line can be either in series or in parallel. Each machine tool is always supplied at its own demand rate. Elastic

HAGEN Synchronous motors



most powerful for its size

Laminated rotor construction of the Model 50 Hagen Motor produces exceptionally high torque. For example, the rotor develops 10 ounce inches torque at 4 RPM. This motor is ideal for those applications requiring from 5 to 10 times the power of clock-type miniature motors. Yet in spite of its power, the motor is extremely compact:

DIMENSIONS

	50 to 60 cycle	25 cycle
A	3-3/32	3-1/16
B	1-13/32	1-23/32

Just a few of the many possibilities for use are: door chimes, laundry timers, depth finders, animated displays, heating controls, program clocks, fire alarm systems, integrators, time switches, chart drives, scoreboards, potentiometer drives. Motor may be mounted in any position. Wide selection of output speeds from 1800 to 1/6th RPM. Reversible and other models available. Send coupon for Bulletin No. 1055.

HAGEN
MANUFACTURING COMPANY, INC.
Moline, Illinois Baraboo, Wis.
Subsidiary of Eagle Signal Corporation

MAIL COUPON TODAY

HAGEN MANUFACTURING COMPANY, INC.
Dept. A-257, Moline, Illinois

Please send Bulletin 1055 on Hagen Synchronous Motors.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

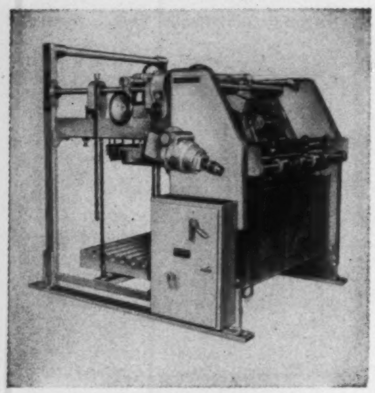
Circle 587 on Inquiry Card

DEXTER
AUTOMATIC
METAL SHEET
FEEDER

Metal sheets, automatically separated, picked up and advanced one at a time to feeding—in point of machine to which it is attached at speeds up to 150 sheets per minute.

Should two sheets adhere, they are automatically transferred to a reject tray. Rubber suction mouthpieces and drop rollers prevent scratching.

Standard Feeder handles metal sheets from 14" x 18" up to 36" x 44" between 24 and 38 gauge stock. Feeders for larger size and heavier gauge metal sheets also available.



Continuous reloading avoids machine stoppage. New loads are placed in feeding position, while machine is operating, thus maintaining continuous automation cycle.

Dexter Feeder may be attached to Metal Litho Presses, Coating Machines, Sorting Machines, Shears, Slitters, Sprayers, Punch Presses, Stove Pipe Machines, Buffers and numerous other metal working machines.

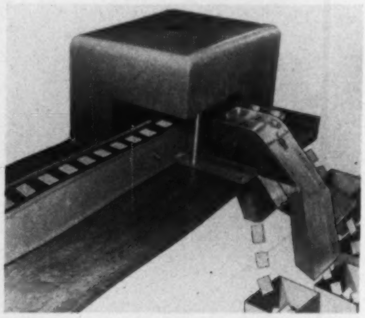
Custom built sheet feeders for handling paper, cardboard, corrugated and other types of sheets are available to meet specific requirements. Inquiries invited.

DEXTER
EST. 1880
DEXTER
FOLDER COMPANY
General Sales Offices
330 WEST 42ND STREET
NEW YORK 36, N. Y.

Circle 588 on Inquiry Card

floats are used in the systems wherever necessary. These floats maintain an even flow of parts through the line, and absorb the differences in productive capacities between successive machine operations. Controls of the demand feed distribution system are made up of standard, conventional components and are independent of the machine controls. **Cargill Detroit Corp.,** 2254 Cole Ave., Birmingham, Mich.

Circle 423 on Inquiry Card



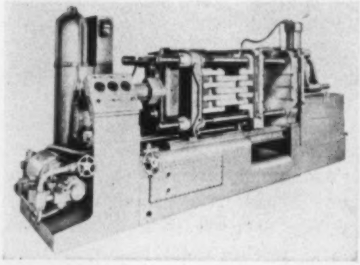
Inspector and Classifier

XactRay Gage High Speed Classifier makes possible inspecting, classifying and sorting by one machine. Classification can be made into any number of categories with adjustable ranges of thicknesses. The accuracy of the gage is 1 per cent of the thickness of the material being measured.

In operation, workpieces, regular or irregular shapes, pass through an x-ray beam whose absorption, proportional to thickness, provides a signal to operate the correct selector gate. The electronic equipment associated with the x-ray beam and x-ray pickup is designed to permit adjustment of the thickness limits of each category. The x-ray beam area can be adjusted from 1/16 to 1½ inches in diameter, so the device is flexible as to the size of the piece checked and the area averaged.

Illustrated application is a sorting table with automatic feed, and a measuring head with five classifier chutes. A split conveyor belt is provided to receive the pieces to be gaged, and to carry them forward into the sorting section. The chutes are designed to pass the pieces into suitable containers placed below the chutes or on to other conveyor belts to carry them to the next operation. **X-Ray Div., Industrial Gauges Corp.,** W. Englewood, N.J.

Circle 424 on Inquiry Card

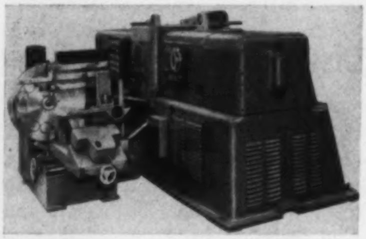


Diecasting Machinery

Designed for fast production, Unicaster Model 120 diecasting machine has a 450-ton capacity. The machine has a compact, self-contained hydraulic system mounted on the subbase of the machine. Elimination of all pilot lines and the coupling of all hydraulic pipes with welded flange fittings reduces the possibility of oil leaks or hydraulic shock.

Another design feature is the simplified tank cleanout with easily accessible oil filters. Tank drainage is not necessary. Electrical operator controls permit operation of equipment on automatic cycle or manual actuation of die closing, core pull or shot. All hydraulic control valves are located within easy reach of the operator. **Unit Products Div., Uniloy Corp.,** Saline, Mich.

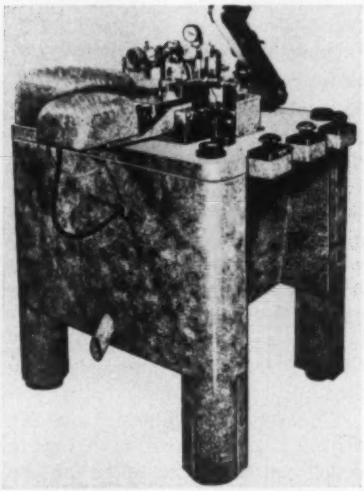
Circle 425 on Inquiry Card



Pushbutton Grinding

Designed for high speed precision finishing of piston rings, bearing rings, automatic transmission plates and similar shapes, No. 240 30-inch double horizontal disk grinder has all-spindle motors contained within the base and pushbutton controls on both sides. Other features of the grinder include at-a-glance reading of head and disk alignment, sealed spindle quill construction, automatic push-button dressing, automatic sizing to adjust for disk wear, edge grain Formica wearing ways, head assembly neoprene-sealed against dust and coolant, fast magnetic rotary throughfeed, and easy disk removal. **Besly-Welles Corp.,** S. Beloit, Ill.

Circle 426 on Inquiry Card



Commutator Turning

Fully automatic commutator turning machine, Model CTM 2000, is an addition to line of electric motor production equipment. By employing diamond cutting tools, the design of the machine allows a single semiskilled operator to turn automatically from 500 to 700 finished commutators per hour. Rough and finish turning can be performed simultaneously by using two diamond tools.

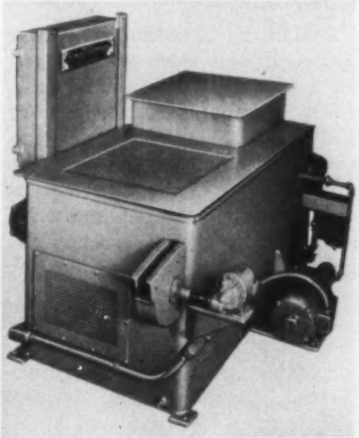
The machine can be quickly adjusted to turn commutators up to 2 inches in diameter and 2 inches in length, with a tolerance of 0.0003-inch or better, and with a 15 mu inch surface finish, if desired. A complete armature change can be made in approximately 15 minutes. The machine is actuated by two electric starting buttons, after which it cycles automatically. An emergency stop button automatically returns all workstations to starting position. Two lubricating systems automatically supply oil to all vital working parts, including the armature shaft journal during the copper removing process. **Motor-Mation Inc.,** 116 W. Ninth St., N. Canton, O.

Circle 427 on Inquiry Card

Gear Washer

Used for any production line cleaning operation where removal of either chips or loose dirt from relatively small parts is important to subsequent machining or inspection operations, compact gear washer smooths out operation of automatic production lines. The unit, which operates at room temperatures, is not limited to the handling of gears, or even round parts. Either magnetic chip separator or self-cleaning filters are available as optional equipment.

Parts may be received by gravity direct from machines on previous operations or from a collecting floor conveyor. The size requirement for parts that can be handled in the washer ranges from fractions of an inch to about 3 inches in diameter. The unit can handle up to 1000 parts per hour, with the parts being spray washed and blown dry as they travel 4 ft through the washer. A variety of washing solutions can be used with the washer, depending on the requirements. A pump is used to spray the washing solution on the moving workpiece, and an oversize scavenger pump is used to pull the solution out of the bottom sump and into the top tank. **Gear-O-Mation Div., Michigan Tool Co.,** 17140 E. Ten Mile Rd., E. Detroit, Mich.



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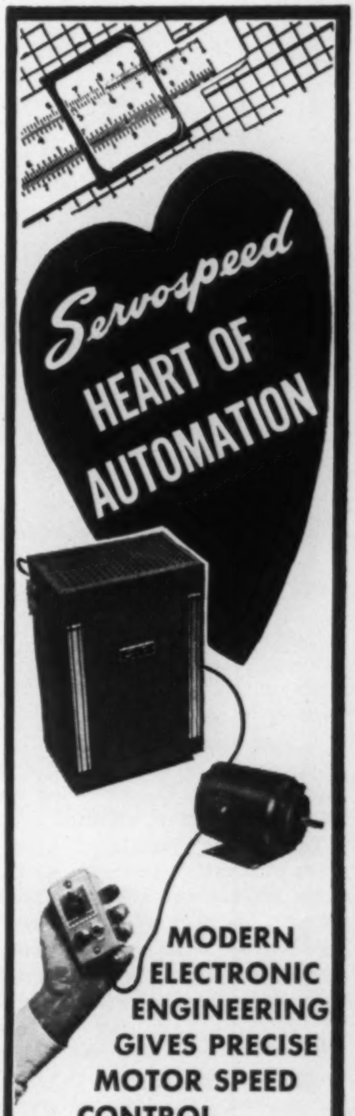
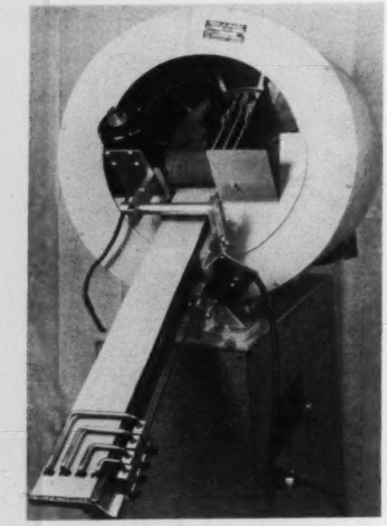


MODERN
ELECTRONIC
ENGINEERING
GIVES PRECISE
MOTOR SPEED
CONTROL

Modern industrial electronic engineering has been coordinated with electric motor design to provide a versatile means for obtaining the full possible advantage of speed control in DC motors while operated from the regular alternating current power line. Grid controlled "Thyratron" tubes are utilized for power controlled stepless variation to supply motor armature power. Patented feedback, or "Servo" circuits provide constant torque capability over wide speed ranges of as high as 60 to 1 in some models and a minimum of 20 to 1 in others.

Servospeed
DIV. of ELECTRO DEVICES, Inc.
4 Godwin Ave., Paterson, N. J.
ARmory 4-8989

Circle 589 on Inquiry Card



Parts Feeder

Used in combination with an automatic stud setter to insert the studs into a diecasting, machine feeds four rows of #12 x 29/32-inch long studs. Four studs, one from each track, are released each time the solenoid controlled release mechanism is actuated.

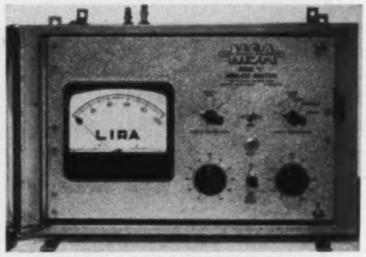
The hopper consists of a cast drum with cast-in pockets. As the drum rotates, the cast-in pockets collect a quantity of items, carrying them up to the orienting chute. A stationary retainer plate gradually closes the pocket as the hopper revolves, capturing the collected items. At the peak of the turn, the retaining plate ends and the product flows into the orienting chute and down the track. Parts not properly oriented are rejected back into the drum. At the end of the track is an adjustable release mechanism which can be set to release one or more parts at a time.

Illustrated machine is an adaptation of the standard Feed-A-Matic which is a high speed parts feeder and counter. It handles a variety of parts such as nuts, bolts, screws, studs, washers, dowels, plastic parts, candies, toy parts, screw machine parts, tablets, pills, capsules, etc. Where the application requires, multiple track delivery of two, three, four or five tracks can be provided. Multiple tracks are used either to supply parts to several stations in an assembly or machining operation, or to provide a greater rate of feed in a counting or packaging operation. **U.S. Engineering Co.,** 40-21½ 22nd St., Long Island City 1, N.Y.

Circle 429 on Inquiry Card

Infrared Analyzers

Precision analytical instruments are designed for industrial applications where it is necessary to quickly and accurately analyze for a single component in a simple or complex mixture of gases or liquids. Completely automatic and continuous in operation, Lira analyzers can be used to control continuous or batch processes, to determine and control product quality, to measure toxic or explosive gas concentrations, and to solve a wide variety of other production and research problems.



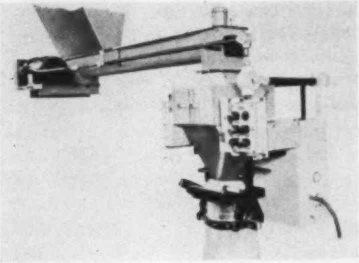
Analyzers can be calibrated over very small or very wide ranges. Units give a continuous and practically instantaneous analysis of the process stream — 5 to 30 seconds for full scale response. Almost all gases, vapors and liquids absorb in the infrared spectrum; consequently, the analyzer is not restricted to the analysis of any particular material or process.

The analyzers are available in two types: Model 100 which incorporates the null balance principle for maximum sensitivity, stability, and selectivity; and Model 200 (illustrated) which gives deflection type indication for less complex applications. **Mine Safety Appliances Co.,** 201 N. Braddock Ave., Pittsburgh 8, Pa.

Circle 430 on Inquiry Card

Automatic Gross Weigher

Distortion-free weighing of difficult adhesive materials is provided by automatic gross weigher. Automatic features of the scale include pushbutton control, automatic feed and bin level switches, and a choice of power feed mechanisms. The scale, called the E-52, feeds directly into a bag suspended from the weigh beam, rather than through a weigh hopper, keeping material continuously in motion until it falls into the bag, and eliminating material buildup and erratic discharge.



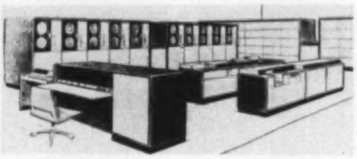
Besides handling such adhesives as carbon black, powdered sugar, powdered milk and starch, the gross weigher accommodates nonadhesive feeds, meal, food products and chemicals. It handles 25 to 100-lb bags at normal operating speeds of five or six bags a minute. Accuracy averages 1 to 2 oz.

To start the weighing cycle, the operator presses a *Start* button which automatically opens an air operated radial gate at the scale's inlet, allowing material to flow into the suspended bag. If power feeders are used, feeder motors start simultaneously. As the preset weight of material is received in the bag, the weigh beam moves toward balance. This closes the inlet gate and stops the feeding. The bag, held on the spout by the bagholder, is released. Automatic feeding can be included by mounting a limit switch on the bagholder. Feeding begins when bag clamps are closed, since limit switch and gate switch are in series. **Richardson Scale Co.,** Van Houten Ave., Clifton, N.J.

Circle 431 on Inquiry Card

Data Processing System

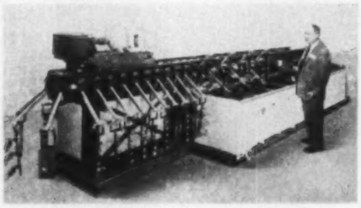
Designed for a wide range of business industrial and scientific applications, electronic data processing system is called the Alwac 800. System is capable of more than 11,000 additions, more than 3000 multiplications or 2000 divisions per second. It can accom-



modate up to 500 words (12 decimal digits) in its rapid access internal (working) memory. The system can retain up to 120,000,000 decimal digits in its multiple drum storage. Drum access time is 4 milliseconds. Multiple magnetic tape units provide increased storage capacity.

The device can automatically process data stored on punched cards, magnetic tape and high speed punched paper tape. In addition, high speed line printers and/or electric typewriters can be used for output. All functions (calculation plus input and output) can be performed simultaneously. **Logistics Research Inc.**, 141 S. Pacific Ave., Redondo Beach, Calif.

Circle 432 on Inquiry Card



Automatic Plating Unit

Designed to fill the need for a production plating unit for small and medium sized parts, Little Steve is a small automatic plating machine with a large capacity for finishing larger parts that do not require extremely high production. The machine is well suited for plating electrical parts, door hardware, plumbing fixtures, pistons, small appliances, etc. It measures only 7 ft in width and 10 or more ft in length. The machine is as well suited for anodizing or other electrochemical immersion processes as it is for plating.

Three handling methods are used for processing smaller parts: the carrier arm acts as a holder for small individual racks; the carrier arm acts as a rack and small parts are attached directly to it; and the carrier arm acts as a rack and the arms are racked rapidly on and off the carrier arm bracket of the machine. The unit has performed satisfactorily in alodine proccessing of aluminum, silver plating, dichromate processing, tin immersion, and copper, zinc, nickel, brass and chrome plating. **Frederic B. Stevens Inc.**, 1800 18th St., Detroit 16, Mich.

Circle 433 on Inquiry Card

Rotating Roll-Clamp

Rolls from 24 to 48 inches in diameter in either vertical or horizontal position are handled by 360-degree rotating clamp for materials handling truck. With this device, rolls in vertical position can be picked up when against a wall or another roll, and rolls in horizontal position can be picked up when there is nothing solid behind them.

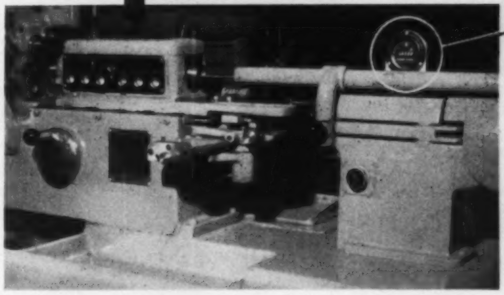
Clamp consists of two hydraulically operated arms which have a range of 22 inches minimum to 52 inches maximum. One is a short thin arm containing an articulated rubber lined pad; the other arm is longer and contains two articulated rubber lined pads. The fixed arm is positioned against the roll and the movable arm does the actual clamping. With new clamp, both arms can be hydraulically movable, but only one at a time. A selector valve on the clamp itself permits the operator to make either arm adjustable and at the same time immobilize opposite arm.

The 360-degree rotation is accomplished by chain and sprockets driven by a hydraulic motor so that the clamp can rotate any number of times in the same direction. **Lewis-Shepard Products Inc.**, Dept. R-12, Watertown, Mass.

Circle 434 on Inquiry Card

Take the guesswork out of

MAINTENANCE
UTILIZATION and
PRODUCTION records



Hobbs
HOUR METERS
for alternating current

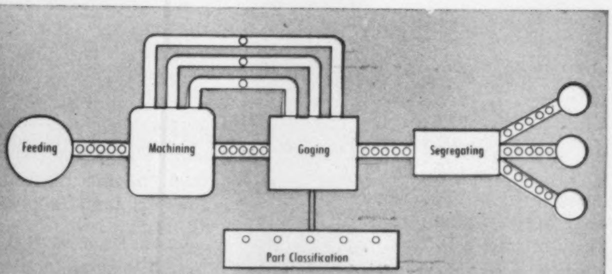
The Hobbs Ac Hour Meter indicates operating time of any machine or equipment powered by alternating current — basic time data essential in the study of utilization and production methods . . . and vital for protective maintenance programs. Wide range of applications — small, compact, easy to install. Ruggedly built and sealed against moisture and dust. Powered by an accurate synchronous motor specially designed for this instrument. Easy to read — tells at a glance accumulated time of operation to 10,000 hours, showing 1/10th hours. Also available in 100,000 hour models.

● Ask your supplier . . . or write direct for Catalog AC-587 with complete informaiton.

John W. Hobbs Corporation
2080 YALE BLVD. SPRINGFIELD, ILLINOIS
A Division of Stewart-Warner Corporation

Circle 590 on Inquiry Card

AUTOMATION DEMANDS *RELIABLE CONTROLS*



Dimensional control is the very heart of automation for the metalworking industry. Consequently, care in the selection of In-Process and Post-Process control devices is very important.

As a long recognized leader in air, electric and electronic gaging, Sheffield is prepared to furnish either:

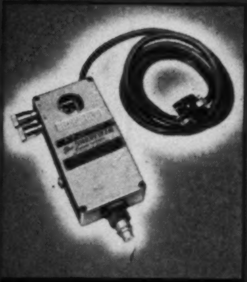
- **Packaged controls and tooling ready to install**
- **Complete automation gaging and transfer systems ready to operate**

FUNCTIONS and ADVANTAGES

- Determine minute dimensional variations, rapidly and with repetitive precision
- Initiate warning signals
- Actuate control mechanisms
- Segregate acceptable, oversize and undersize parts
- Accurately classify parts by sizes
- Accommodate almost limitless range of tolerances
- Operate with interchangeable tooling
- Are small, compact and easily mounted
- Have unusually long, trouble-free service life
- Are easily interchanged

7125

Shown here are a few of those Sheffield control units so widely used in automated systems.

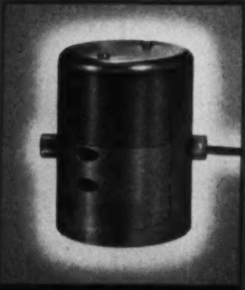


AIRLECTRIC

A limit type pneumatic control to actuate signals and relays.

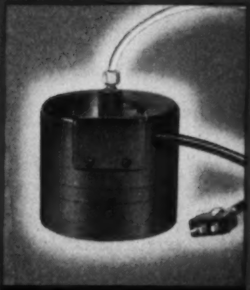
LECTROLAIR

A sealed-in control to actuate signals and relays and also to give visual size indication.



DIFFERENTIAL

A gage head for checking taper, hole parallelism or hole center distance and converting the result into an actuating electrical impulse.



VARIATION

A pneumatic gage head for external or internal dimensions and face to axis runout—converts the result into an actuating electrical impulse.

For more detailed information,
write for Bulletin AU-1154

The Sheffield Corporation
Division 3
Dayton 1, Ohio, U.S.A.

MASTER CRAFTSMAN SHEFFIELD HEADQUARTERS

SHEFFIELD

MANUFACTURE AND MEASUREMENT FOR MANKIND

Circle 591 on Inquiry Card

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

For detailed information and literature, use card page 17

Diesel Engine Control

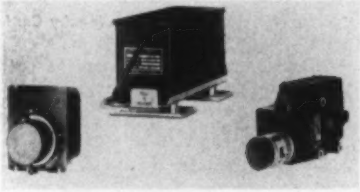
Automatic start and stop with protective shutdown features are provided by heavy-duty Electrostart diesel engine control. The unit operates on 12, 24, and 32v, and can be used with any diesel engine equipped for storage battery starting. The control operates from any type of remote pilot switch, including automatic transfer, temperature, pressure, float or load demand type.

The unit is available for five-shot (interrupted cycle) or one-shot (single-cycle) cranking. Length of the crank period of the one-shot model, adjustable from 5 to 60 seconds, is controlled by means of a gas displacement pneumatic timer of high reliability. The interrupted cycle model employs a universal gear motor and programmed cam to give five equal crank periods with four equal rest periods between. The timing cam can be provided with any desired cranking program. Crank periods are available from 5 to 30 seconds with overall cranking time of 25 to 150 seconds. Both controls automatically reset when the engine starts or stops. A four-position switch on the control panel provides manual, automatic, test and off positions. Automatic reset after a failure is done instantly by turning the switch to off position. **Lake Shore Electric Corp.,** 510 Willis Ave., Bedford, O.

Circle 435 on Inquiry Card

Remote Positioning

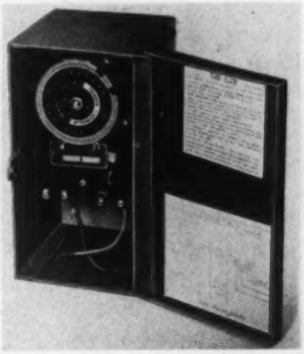
Used in such operations as fuel mixture and throttle control on engine test cells, valve operation in process work, and remote manipulation in radioactive or hazardous locations, remote positioning system transmits motion with appropriate output power. The system is composed of three basic components: A transmitter, amplifier and receiver.



The positioning system does not allow an undesired signal to move the output shaft. Any form of motion can be transmitted or received, either linear or rotary. Power supplies of amplifier and receiver need not be identical; amplifier requires 115v, 400 cps supply, but the receiver motor may operate on most available power supplies. Input-output ratio can be 1 to 1 or any other desired ratio.

Accuracy of the system is independent of load, since the receiver motor gets full voltage for any error signal exceeding the deadband, which can be as low as 0.2 per cent of scale. Manual override, inching control and interlock features are optional. **Bristol Co.,** Waterbury 20, Conn.

Circle 436 on Inquiry Card



Three-Pole Time Switch

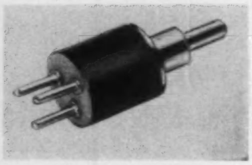
Multiple circuit, automatic *On-Off* control is provided by Model 1963 three-pole time switch. Developed to answer the demand for controlling three-phase power and lighting loads, the switch is available in four dial styles—regular 24-hour dial, skip-a-day dial for eliminating weekend operation, astronomic dial for lighting to conform with the sun's schedule, and seven-day dial to program an entire week's schedule on one dial.

One application of the device is the switching of three separate 120v circuits leading from a subpanel. Switch can also be used to control a 1½ hp three-phase motor direct. Electric heater loads may be controlled up to full rated capacity as well, (a total of 7500w) since each pole of the unit is conservatively rated at 25 amp. **Tork Clock Co. Inc.,** Mt. Vernon, N.Y.

Circle 437 on Inquiry Card

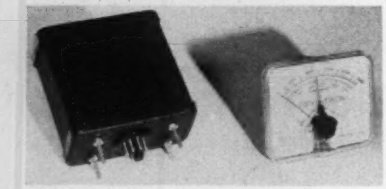
Potentiometer

Designed for use in printed circuits and automated assembly, plug-in, ½-inch precision potentiometer is designated Model APP-½. Simplifying installation in mini-



aturized assemblies that use printed circuit techniques, the potentiometer is provided with a three-prong base that fits standard three-circuit microphone sockets. The plug-in connection afforded by this unit is also advantageous in automated assembly where precise positioning and rapid installation are essential. The potentiometer is available in resistance ranges of 10 to 100,000 ohms, with standard accuracy of 5 per cent below 50k and 2 per cent above 50k. **Waters Mfg. Inc.,** P. O. Box 368, S. Sudbury, Mass.

Circle 438 on Inquiry Card



Relay Control Pack

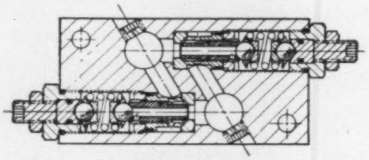
A miniaturized plug-in control pack which contains all the basic control circuitry needed for use with contact meter-relays, increases the flexibility with which meter-relays may be designed into production equipment. Although a large number of circuit variations are available in the control pack, the standard minimum parts include an isolation transformer, a dc power supply (including rectifiers), and slave relays to provide 5 amp ac, 115v contacts.

An advantage of the control pack is that it can be replaced with a pack having different circuitry if control requirements change, without disturbing the meter relay or associated equipment on the control chassis. Size is approximately 2 by 4 by 4 inches. The unit plugs into standard 11-pin octal type sockets. Four mounting studs provide additional mechanical support. **Tipp-Tronic Inc.,** Tipp City, O.

Circle 439 on Inquiry Card

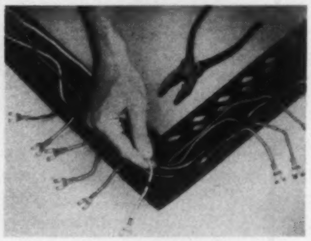
Dual Relief Valves

Engineered to relieve shock pressures that occur at control valves or motors, line of hydraulic relief valves is available in either piston or differential piston types. The valves protect hydraulic components and systems from excessive pressures that occur when control valves are suddenly reversed or blocked, or when an external load is applied to a motor. They also assure smooth, safe starting and deceleration of heavy loads.



Units consist of two adjustable relief valves integrated into one body. Each valve relieves in one direction and can be adjusted to the same pressure or to different pressures. When oil pressure exceeds desired setting, oil is relieved from the line and directed into the other line, thereby eliminating the necessity for a connection to the system reservoir. **Fluid Controls Inc.,** 1284 N. Center St., Mentor, O.

Circle 440 on Inquiry Card



Panel Channel Raceways

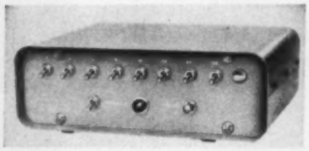
Developed to permit quick wiring of electrical and electronic equipment with precut wires already equipped with solderless connectors, panel channel raceways eliminate wire bundling and lacing. The devices also reduce copper loss in any wire grouping operation. Design of the raceway provides slots instead of holes. Wires with terminals can be passed through the slots with no sacrifice in structural strength of the raceway. Arrangement of the wire slots permits wiring to leave the channel on the same plane as the destination terminal. A range of sizes from 1 by 1 inch to 4 by 4 inches is available. **Stahlin Brothers Inc.,** 232 Maple St., Belding, Mich.

Circle 441 on Inquiry Card

Three-Minute Synchros

Valuable in applications requiring accuracy with minimum bulk and weight, three-minute Size 23 synchros meet performance requirements of military standards. Units are engineered to enable design engineers to increase the accuracy in their control and data transmission systems and servomechanisms. The synchros often eliminate the need for two-speed synchro systems, thereby reducing cost and effecting appreciable economies in weight, size, complexity and gearing problems. Electrical error is 3 min., max.; frequency, 60 or 400 cycles; 90 and 115v. Matched pairs of synchros are available to provide even greater system accuracy. **Norden-Ketay Corp.,** Commerce Rd., Stamford, Conn.

Circle 442 on Inquiry Card

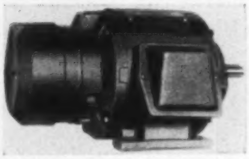


Digital Counter

Teamed with appropriate conversion equipment, transistorized digital instrument counts articles, distance, degrees of rotation or angular measurements, at high speeds. Dependable operation is achieved by using transistors instead of vacuum tubes. Small size is obtained by employing printed circuit boards and modular construction. Total power consumption of the counter (2w) is no more than the filament power required by a typical tube.

Counting frequency of the device is 15,000 cps, with higher speed provided as a special. Input power is 60 cycle, 85 to 140v. Resolution is 10 microseconds. Counter can be preset anywhere from one to 500 for batch counting. In operation, the output of a suitable transducer is sent to transistorized flip-flops within the counter. These in turn, when the desired number is reached, cause an output relay to function. **Nader Mfg. Co.,** 2661 Myrtle Ave., Monrovia, Calif.

Circle 443 on Inquiry Card



Brake Motor

Developed to stop instantly and hold heavy loads, line of rugged, cast iron brake motors has totally protected components to assure long life and trouble-free operation on all types of equipment from bottle washing machinery to heavy duty cranes. Features include a wide torque range from 3 to 345 ft-lb, one-piece molded friction linings for quick stops, and one-operation torque setting.

In the event of power failure or low voltage, "dead man" operation sets and holds the load until normal operation is restored. All types of enclosures are available including those suitable for outdoor installation or where extremely moist, corrosive, or abrasive dust conditions exist. Standard enclosures include protected, totally enclosed nonventilated, totally enclosed fan-cooled, and explosion-proof. **Reliance Electric & Engineering Co.,** 1088 Ivanhoe Rd., Cleveland 10, O.

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Saves 40% Space!

STRONGER, TOO

Than Outmoded
Tie Rod Cylinders!

OFF SHELF DELIVERY

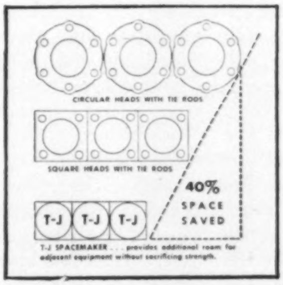
Only T-J

Spacemaker

CYLINDERS

Offer All The Extras As Standard!

- NEW *exclusive* Ingenious Cushion Designs . . . Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Oil Cushion
- Compact design eliminates tie rods, saves up to 40% space
- Proven Performance . . . with Extra High Safety Factor
- Hard Chrome Plated Bodies and Piston Rods (Standard, at no extra cost)
- OIL pressure up to 750—AIR to 200 P.S.I.



T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

You'll find many answers to *automation* in your plant with T-J Spacemaker Cylinders! Designed with years-ahead features for top performance and dependability. Wide range of styles, capacities . . . for all kinds of push-pull-lift operations . . . reduces man-hours and costs! Write for bulletin SM-155-2. The Tomkins-Johnson Co., Jackson, Mich.

MEMBER OF THE NATIONAL FLUID POWER ASSOCIATION

T-J TOMKINS-JOHNSON
RIVITORS . AIR AND HYDRAULIC CYLINDERS . CUTTERS . CLINCHORS

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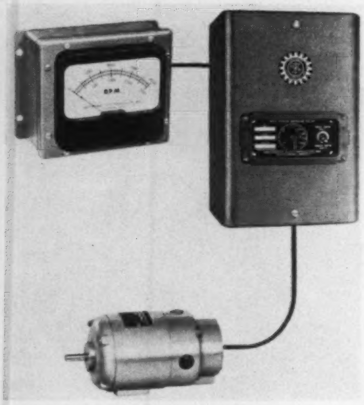
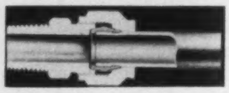


Speed Sensor Relay

Speed can be used as a controlling quantity with relay which is designated MEK-2060. For example, processing or testing cycles can be automatically started after a preset speed has been reached. The relay can also be used as an underspeed or overspeed limit device.

Applications of the relay include: Indicating when zero speed has been reached to provide additional interlocking before releasing an automatic chuck or machine tool; automatically starting a test run when a predetermined speed has been reached; and automatically synchronizing two process machines. Repetitive accuracy of speed detection is within better than ±2 per cent. Accuracy of calibration of the dial scales is within approximately ±5 per cent. Precisely calibrated dial scales can be provided when required. The control unit is available in either open or enclosed styles. The compact tachometer generator is of totally enclosed, nonventilated construction and can be remotely mounted from the control unit. **Machinery Electrification Inc.**, Northboro, Mass.

Circle 445 on Inquiry Card

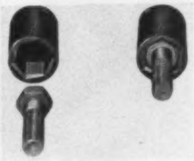


Tube Fitting

Engineered for applications in any type hydraulic and pneumatic circuit, Hi-Seal flareless tube fitting makes a butt-tight joint and is designed for a full range of pressure conditions. Since a butt joint is formed, the tubing need not be sprung when making assemblies. This feature is advantageous when working with large size, heavy wall or hard-temper steel tubing.

Available in steel or stainless steel in a variety of sizes, the fitting consists of a body, nut and alloy steel sleeve. A shoulder on the sleeve prevents incorrect assembly. Three serrated edges on the sleeve bite radially into the tube surface to a controlled depth, making a triple seal. It will not move longitudinally in assembly, scrape or shave tubing, and there is no torquing of the tube when making a joint. The fitting may be used with steel, stainless steel, copper, aluminum, Everdur and Monel tubing, and is available in a variety of types and shapes, in sizes for ⅛ to 1½-inch OD tubing. **Imperial Brass Mfg. Co.**, 1200 W. Harrison St., Chicago 7, Ill.

Circle 446 on Inquiry Card



Impact Socket

Designed to meet the demand for automation in production fastening operations, fast lead type impact socket has a specially designed broached opening which allows the socket to fully engage the nut in 1/6-turn. Using these sockets, single or multiple power tools may be operated continuously, thereby speeding up the entire fastening operation. It is not necessary to start and stop the power tool for each operation, nor is it even necessary to hesitate before the socket makes initial contact with the nut. Sockets are offered with hex broached openings ranging from ⅜ to 1-inch. The photograph illustrates the unengaged socket at the left and the engaged device at the right. **Apex Machine & Tool Co.**, 1036 S. Patterson Blvd., Dayton 2, O.

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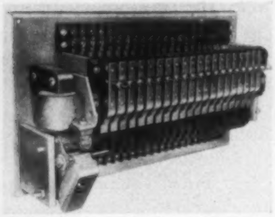
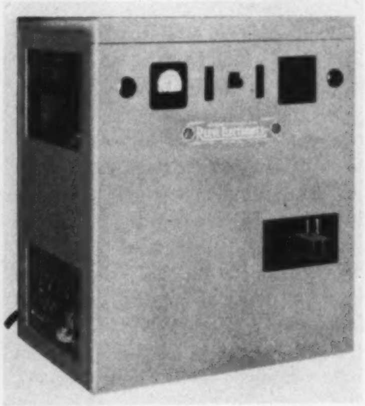


Heavy Duty Step Switch

Used to provide a positive interlock between sequence operations on one or more machines, on conveyor systems, batch mixing, etc., heavy-duty step switch is designated the MT Series. The switch carries contact ratings of 10 amp; rotary solenoid actuating coil operates directly on 115v, 60-cycle current without the use of rectifiers.

The switch is available with one to 20 independent circuits. Independent cam-operated contacts make it possible to set up any combination or group of combinations desired for a given application. Use of the device simplifies circuits and often eliminates the use of auxiliary relays and other electrical components. **Eagle Signal Corp.**, Moline, Ill.

Circle 448 on Inquiry Card



Induction Heater

Used for soldering, brazing, hardening, annealing and many other production operations, 2 kw induction heater is addition to the Reevelec line of R-F induction and dielectric heaters. The Model L6E bench mounted unit features a built-in output transformer for matching a variety of load shapes and sizes; a built-in automatic recycling heat cycle timer with a wide choice of ranges; circuit breaker protection of both line and high-voltage circuits; outlet for interconnection of remote switches, turntables or other fixture interlocks; watercooled coil and transformer circuits and a forced air cooling system for the entire unit. It is equipped with protective interlock switches on all access doors and has grounded low-voltage output circuits. **Reeve Electronics Inc.**, 609 W. Lake St., Chicago 6, Ill.

Circle 449 on Inquiry Card

Temperature Control

The sensitivity of a thermistor bridge circuit is combined with the dual indicating and controlling function of a contact meter relay in temperature control package. Unit acts upon a temperature change as small as 0.075F. The thermistor sensing element can be located as far as 200 ft from the controller without effecting indicating or controlling accuracy. No intermediate amplifier is required.

Models are available in a number of temperature ranges, beginning with a minimum span of 15F spread over a full meter scale of 95 angular degrees. Limits of the temperature range are −75 to 300C. Control action is initiated when the indicating pointer reaches the preset limit of the adjustable pointer. Either automatic *On-Off* or locking limit control action is available With *On-Off*, the desired control action occurs at the preset temperature limit, but the device continues to test the temperature periodically to maintain the oven, furnace or process at the proper level. With limit control, the unit locks up, turning the heat off, and must be reset manually each time the temperature reaches the control point. **Assembly Products Inc.**, Chesterland, O.

Circle 450 on Inquiry Card

NO REASON WHY YOU CAN'T DO IT, TOO!

MUELLER CLIMATROL, Milwaukee, increases paint mileage 40% with RANSBURG NO. 2 PROCESS

Typical of the Mueller Climatrol line is this summer air conditioner and gas-fired winter air conditioner, now uniformly painted electrostatically with RANSBURG NO. 2 PROCESS

And, 10 men averaging 40 hours a week now do the work formerly handled by 24 men averaging 50 hours!

Painting used to be a bottleneck in the manufacture of heating and air conditioning equipment at Mueller Climatrol.

But not any more!

When Mueller modernized its finishing department—replacing hand spray with Ransburg No. 2 Process Electro-Spray—daily production was increased . . . finishing costs were cut . . . and quality of the work was improved.

Annually, Mueller coats over 10 million square feet of sheet metal, so a 40% increase in paint mileage—translated into paint dollars saved—is a sizeable figure. Pointing up other savings, a typical run of 400 furnace casings used to take 200 man hours to clean and hand spray. Mueller does it now in 60 hours!

NO REASON WHY YOU CAN'T DO IT, TOO!

Whatever your product, if your production justifies conveyorized painting, chances are one of the Ransburg Electro-Coating Processes can do it better, for less, with improved uniformity and quality of the work. Write for our new brochure which includes numerous examples of both large and small manufacturers of a variety of products who are enjoying the many advantages of *Ransburg Electrostatic Spray Painting.*

Ransburg ELECTRO-COATING CORP.
Indianapolis 7, Indiana
RANSBURG

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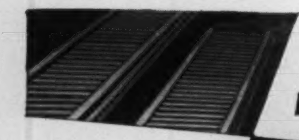


Most ANY Company Can Make
LENGTHS of Roller Conveyors .

But Only... A-F Engineered Plantwide
Conveying Systems Can Give You
A-F Engineered Savings!

Yes, we make and sell low-cost general purpose roller conveyor units—straight sections and curved—for moving loads by gravity or by hand. Also lengths of A-F "Live Rail" Wheel Conveyors, A-F "Trol-E-Veyors" and other pre-engineered units, each, we believe, is superior to anything in its classification.

BUT—If you want to make the one kind of year-after-year savings now possible—*operational savings* —you owe it to your company to investigate the efficiencies possible with an A-F *Engineered* plantwide conveying system.

Perhaps an A-F completely coordinated automatic system can be engineered to move empty and filled cases through your plant from a central station by one electrically controlled panel. Or, perhaps, an A-F Engineered System that moves pallets of cartons from floor to floor, then to storage or shipping, will save you money.

Before you order any type of conveyor, write us. We'll be glad to submit an estimate.

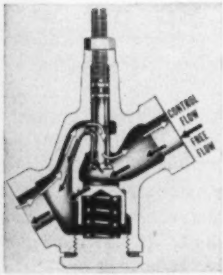
YOU CAN SEE THE SUPERIORITY OF A-F CONVEYOR ENGINEERING

A-F

A-F *Engineered* Conveyors
Custom Engineered Conveying Systems
Pre-Engineered Conveyors—Wheel, Trolley
Metal Cleaning and Processing Machines

THE ALVEY-FERGUSON CO., 170 Disney Street, **CINCINNATI 9, OHIO** and Azusa, Cal.

Circle 594 on Inquiry Card

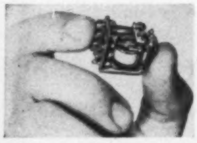


Speed-Control Valve

Designed to provide split-second timing of piston movement by positive control of air flow, speed-control valve features a screw driver slot. The valve is also available with regular knob adjustment or pin lever adjustment. It can be mounted in any position, at either or both ends of a cylinder to provide air flow adjustment.

The valve is designed for ease of adjustment and maintenance. It can be disassembled easily without breaking the line connection, and its construction is simple because the only moving part is the poppet. **Ross Operating Valve Co.,** 120 E. Goldengate Ave., Detroit 3, Mich.

Circle 451 on Inquiry Card



Three-Pole Relay

Used in small business machines, alarm systems, automated toys, remote controls, and intercom systems, subminiature three-pole relays in this series occupy less than 1 cubic inch of space. The series is engineered to meet the demand for miniaturization and multiplicity of action within a single relay.

Contacts are maximum three-pole, double-throw, 3/32-inch diameter silver, and carry 2 amp, 115v, 60 cycle resistive. Voltage range is up to 48v dc nominal with pull-in at 75 per cent of nominal value. Resistance is up to 6700 ohms; power requirement, 1 watt. Temperature range is −45 to 55C. **Potter & Brumfield Inc.,** Princeton, Ind.

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WANTED

Technical Editor

Here is a real challenge for the right man with enthusiasm for writing and a strong creative urge to broaden his perspective and assist industry in effectively applying the techniques of automation.

Edited by a competent staff of experienced engineers, AUTOMATION has an opening for an engineer with diversified manufacturing or production equipment design background and editorial or other writing experience. He should be able to write well, be familiar with automation engineering and have evidence of same.

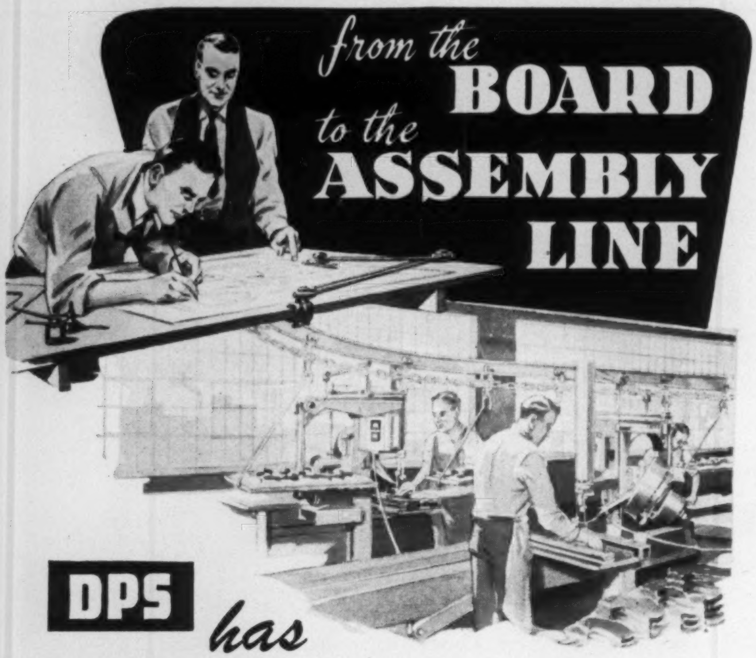
Duties include development, writing, editing articles and feature departments.

There will be opportunity to travel on editorial assignments and attend meetings, expositions, etc.

Headquarters in Cleveland, Ohio.

If you are interested and feel qualified, please send full details of your practical engineering and writing experience to the Editor, AUTOMATION, Penton Building, Cleveland 13, Ohio.

Circle 595 on Inquiry Card



from the BOARD to the ASSEMBLY LINE

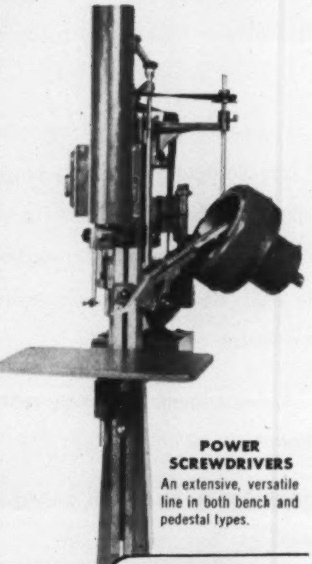
DPS *has*

the technical know-how to "*engineer*" more speed and profit into your assembling operations.

- The signal success of DPS trained engineers in adapting power equipment to the individual feeding and assembling needs of industrial plants everywhere is assurance that they can likewise solve your special problems. In our broad line of

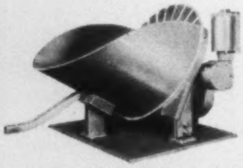
SELECTIVE PARTS FEEDERS
POWER SCREWDRIVERS
SPECIAL ASSEMBLING MACHINES

equipment can be selected, and custom features incorporated, to fit your requirements. Plan now to use DPS modern assembling methods. Tell us your set-up. Write for catalog and further details.

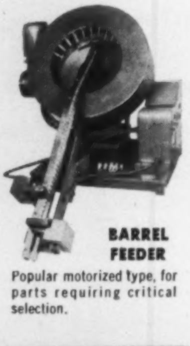


POWER SCREWDRIVERS
An extensive, versatile line in both bench and pedestal types.

BOWL FEEDER
Electrical vibratory type to feed parts that cannot be tumbled.



BARREL FEEDER
with stationary ring cover for heavy-duty production.



BARREL FEEDER
Popular motorized type, for parts requiring critical selection.

DETROIT POWER SCREWDRIVER CO.

2811 W. FORT STREET • DETROIT 16, MICHIGAN

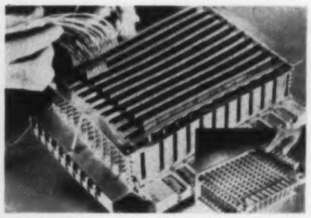
Circle 596 on Inquiry Card

Compact Lubricator

Designed to meet the needs of machine tool manufacturers and users for a small, compact lubricating unit, the cabinet type 33AG-4 supplies air actuated feed mechanisms, chucks, clutches, brakes and other air-operated parts of machine tools with filtered air, regulated air pressure and oil-fog lubrication.

The unit features fog lubrication with oil particles of micron size, visible oil feed for accurate flow control and proof of lubrication, lubricator performance over an air flow range of 4 to 85 cfm, 5/8-pint oil reservoir, clear and wide-angle visibility of oil level, easy oil refilling, relieving type pressure regulator, choice of 64 or 25-micron filter element, optional location of filter drain, and two auxiliary air takeoffs for supplying filtered air for other than lubrication purposes. Lubricator is designed for main line air pressures not exceeding 150 psi, and for regulated air pressures of less than 125 psi. **C. A. Norgren Co.**, 3400 S. Elati St., Englewood, Colo.

Circle 453 on Inquiry Card



Crossbar Switch

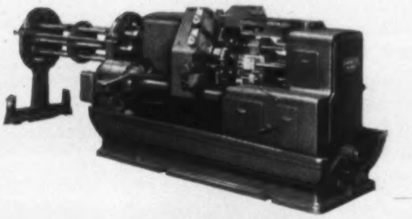
Used in low-level systems such as thermocouple scanners, telemetering systems, strain gage monitoring systems, and process control installations, crossbar switch of-

FROM DIESEL ENGINE TO ICE-CREAM FREEZER PARTS

804
804
PRODUCTION MACHINERY
GREENLEE

AUTOMATIC BAR MACHINES

Handle All Types of Jobs



SIX AND FOUR-SPINDLE AUTOMATIC BAR MACHINES

GREENLEE Special Machine Tools

- Multiple-Spindle Drilling and Tapping Machines
- Transfer-Type Processing Machines
- Hydro-Borer Precision Boring Machines

✓ ***Efficiently . . .***

✓ ***Economically***

Greenlee design permits the handling of a wide variety of operations at various spindle positions . . . makes it easier to split up long operations . . . reduces idling time.

Threading, tapping and reaming can be performed in 3rd, 4th, 5th and 6th positions . . . a special Greenlee advantage. Seven full-length T-slots on the main tool slide will accommodate the tools and attachments needed for a wide range of set-ups. Interchangeable cross-slide tooling and simplified cross-slide camming contribute to greater flexibility and faster set-ups.

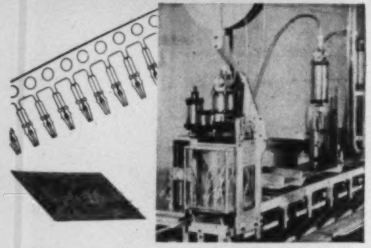
Investigate! Ask any owner or operator . . . they'll tell you that Greenlee is one of the most highly respected names in its field.

Write for Catalog No. A-405

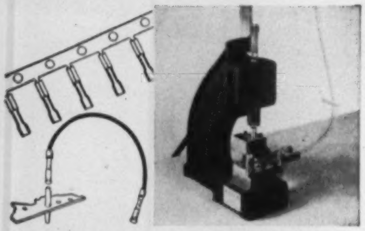
GREENLEE
BROS. & CO.

2082 MASON AVE.
ROCKFORD, ILL.

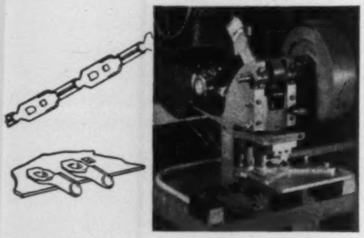
a complete line of
Printed Circuit Hardware
and
Terminal Inserting Equipment



Tubular Pin Terminals—Insert automatically into printed circuit board at huge production savings. Snap into position with positive locking action by means of self-retaining snap-in feature. Double ends permit wrapping or inserting leads at either end. Ask for Bulletins 550 and 551.



Solderless Wire Disconnect Female Terminals—Speedily applied to leads by means of cost-saving automatic equipment. Fits quickly and firmly to tubular pin terminals. Solderless wire crimp can be varied to fit various size insulated wires. Ask for Bulletin 553.



Line Cord Interlock Terminals—For single or multiple lead connections. Another Malco automation development to provide production short cuts and assembly economy. Terminals are staked quickly and firmly into printed circuit boards. Ask for Bulletin 554.

Malco printed circuit hardware can be engineered to your specific requirements. Give us the facts about your operation. We'll show you how your costs can be lowered and your production increased. Ask for Bulletin 551.

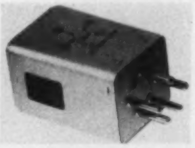
Malco TOOL and MANUFACTURING CO.
4017 W. Lake St., Chicago 24, Ill.

Circle 598 on Inquiry Card

fers a simplified high-speed logic, together with good electrical characteristics. Available in a number of matrix arrangements, the Type F switch offers a flexible high-speed means of selecting information remotely from a large number of sources (up to 1200 per switch) without the necessity of scanning intermediate points.

Because of the digital arrangement of its actuators, the switch can be set up by means of punched cards, punched tape or telephone type dials. Closely held timing tolerances make it possible to operate the switch at high speeds with little lost time for commutation. Because of the balanced nature of connections within the unit, the thermoelectric potentials generated by the switch are held to a low value. In the range of 25 to 50C, the potential is less than 0.01 mu v/C. The switch uses a high-pressure contact which is of the twin bar type, and is available in either palladium or gold. **James Cunningham Son & Co. Inc.,** Rochester 8, N.Y.

Circle 454 on Inquiry Card

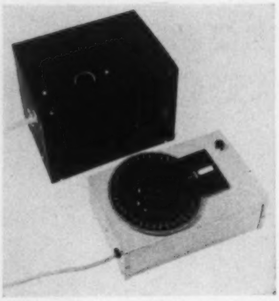


Photoelectric Control

Used for such applications as furnace flame-out controls, pinball machines, elevators, conveyors, weighing equipment, automatic bottle washing machines and bagging machines, photoelectric control utilizes a broad area cadmium sulfide photocell and Sigma Series 41 relay. Components are mounted on a five-pin, plug-in base and housed in a dust can measuring 1½ inches square by 2¼ inches high.

Model 1 CDS Photorelay operates at 5 ft-c or less and releases at 0.1 ft-c or more, at a guaranteed speed of two operations per second. Supply voltage of the device is 115 ac, 50/60 cycles and temperature range is −40 to 75C. **Sigma Instruments Inc.,** 59 Pearl St., S. Braintree, Boston 85, Mass.

Circle 455 on Inquiry Card

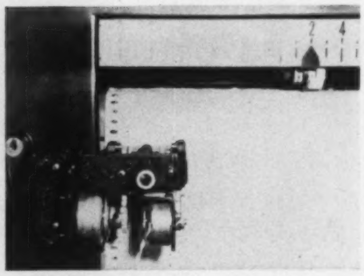


Automatic Positioner

Applicable in the remote positioning of valves and dampers, remote instrumentation in conjunction with indicating instruments, and as the control element in automatic selection equipment, automatic positioning device is designated Model AS. Employing an unusual application of bridge circuitry, it provides positioning accuracy within 0.5 per cent and repeatability within 0.25 per cent. No vacuum tubes or photocells are used.

One application of the automatic positioning control is on a conveyor operating at 100 fpm. In this application the Model AS motorized control selects the shortest route from any position to the desired control point when the control knob is turned to the desired position number and the start button depressed. **Wallson Associates Ltd.,** Newark, N. J.

Circle 456 on Inquiry Card

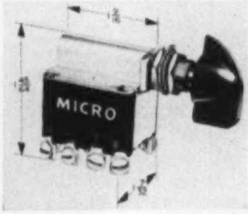


Counter & Printer

Called the Model RI-4 Identichart, compact counter and printer automatically counts and then at some particular time, prints the count. Unit can be caused to print at regular intervals so that it is possible when reviewing the chart to determine the number of counts in any particular time period. Identichart is well suited as a printout device for integrators and mounting can be provided for most recorders. It can also be supplied as an independent unit for printing on a card or adding machine tape. Model RI-4 can be supplied with as many as eight digits, so that a maximum count of 100 million is possible.

Printing does not affect the counting so that the counting can continue after printing the particular number; counting circuit and printing circuit are independent of each other. Both the counting solenoid and the printing solenoid can be supplied for any dc voltage from 24 to 220 and rectifiers can be supplied for use on ac if desired. **Royson Engineering,** Hatboro, Pa.

Circle 457 on Inquiry Card



Rotary Toggle Switch

Designed to solve the problem of controlling many circuits with single-motion, mechanical actuation, rotary toggle switch can handle a high electrical load, thus eliminating the use of relays and other electrical devices. It is rugged enough for most industrial applications, having successfully passed impact, shock, acceleration and vibration tests.

The four-pole, double-throw switch, designated 4TRI, is maintained in all three actuation positions: *On-Off-On*. It has 12 terminals. Other models are available with up to 24 terminals (eight poles). Switch has an operating force of 9 in.-lb maximum. Electrical rating is: Continuous capacity of 30v dc; 20 amp resistive; 5 amp lamp or 12 amp inductive. At 115v ac, the unit is rated at 20 amp resistive; 4 amp lamp and 15 amp inductive. **Micro Switch Div., Minneapolis-Honeywell Regulator Co.,** Freeport, Ill.

Circle 458 on Inquiry Card

30-STEP SPEED CONTROL
WITH A
twist of the wrist!
Speed Control
Power Unit
Drive Motor
Baldor
ADJUSTABLE SPEED
MOTOR SYSTEM

- Easy to install...simple to service!
- No troublesome protective relays!
- No flashing contactors!
- No complicated electronic adjustments!

Specially designed for machines where friction or torque is constant from high to low speed. Motor-generator set, controller and drive motor can be mounted independently, in any position.

- *One* control for all adjustments. 0 to 2400 RPM in 30 steps of 80 RPM, forward or reverse.
- Totally enclosed Streamcooled construction . . . vernier rheostat for infinite speed control between steps . . . jog switch for machine adjustments . . . reversing switch changes rotation . . . many other features.
- Ideal for use on conveyors, pumps, mixers, shaker screens, packaging machines, fans and blowers, farm machinery, governor controls, similar machines.

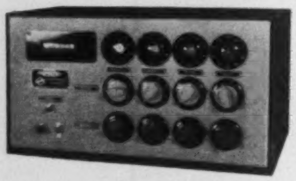
For complete engineering data
write for Bulletin SP-600

BALDOR ELECTRIC COMPANY
4353 DUNCAN AVE. ST. LOUIS 10, MISSOURI

Circle 599 on Inquiry Card

MODEL PW-4

POST
DECITRON



Preset Electronic
Counter

One of a series . . . the Post PW-4, with warning signals, is an electronic counter in the 1-10,000 range.

Any desired batch count from 1-10,000 may be selected on the top row of switches and, if desired, a warning solenoid, feed gate, or similar action can be activated by setting the lower row to your "warning count".

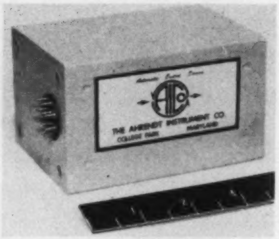
Visual totalizer registers batch counts . . . the counter, itself, resets to zero when preset number is reached. For all electronic counting, timing, or synchronizing problems, consult POST. Write for literature.

Decitron
Electronics
Products
Division

POST

POST MACHINERY COMPANY
Beverly, Mass.

Circle 600 on Inquiry Card

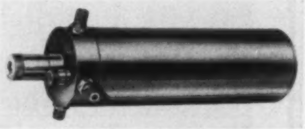


Magnetic Amplifier

Designed for use in instrument and computing servosystems, magnetic amplifier is designated No. C-150-223. Although designed for self-contained 400 cps input signals, the unit is adaptable to input signals from dc to 1000 cps with the addition of a reference transformer. The amplifier does not require any vacuum tube or transistor driving stage in a normal servoloop.

Unit employs no tubes or transistors; the circuit is of full-wave design. Coils and rectifiers produce negligible temperature rise and provide reliable performance with a minimum adjustment. **Ahrendt Instrument Co.,** 4910 Calvert Rd., College Park, Md.

Circle 459 on Inquiry Card



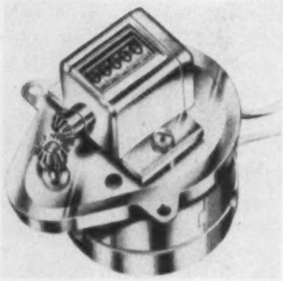
Versatile Controller

Automatic vacuum and pressure control are achieved by control unit called the Cartesian Manostat #10. The device is based on the Cartesian diver principle of an inverted float in mercury. The high capacity, sensitive unit is entirely automatic and self-contained. It requires no additional equipment of any kind.

The device contains a permanent, accurate memory system. Once the vacuum or pressure is set in the Manostat, the setting will not be disturbed even if the system is closed down and later reopened. Other features include a balanced orifice which preserves sensitivity at high capacity and permits direct or reverse action in the same instruments. Linear ball bearings provide nearly frictionless motion of the float. Unit has a direct connection to the reference gas underneath the float.

The instrument is suitable for distillation, evaporation and reaction vessel control systems, for precise flow control in gaseous systems, and for precise control in the distillation of sensitive materials. **Manostat Corp.,** 20-26 N. Moore St., New York 13, N.Y.

Circle 460 on Inquiry Card

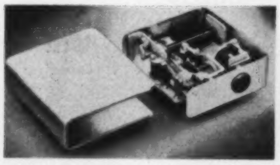


Time Indicators

Used to provide a daily and a total running time record for any electrical or electronic equipment, line of basic elapsed time indicators is available in dc and ac types. The 7500 series dc units employ standard or chronometrically governed dc motors, while the 12500 series ac units use synchronous 50 or 60-cycle motors and the 24200 series use synchronous 400-cycle motors. Supplied with five digit counters, the small units are compactly designed to keep weight to a minimum. A wide variety of ranges or motor types can be supplied to meet specific requirements. Reset units and hermetically sealed housings are also available.

The low power consumption of the indicators makes it practical to locate them remotely where records can be maintained without visiting each machine to be timed. In the dc units, power consumption is dependent on operating voltage. The standard motor has a tolerance of ±10 per cent at rated voltage, while chronometrically governed motors have a tolerance of ±0.001 per cent at ±2 per cent rated voltage. Either type can be supplied with radio interference filtering. **A. W. Haydon Co.,** Waterbury, Conn.

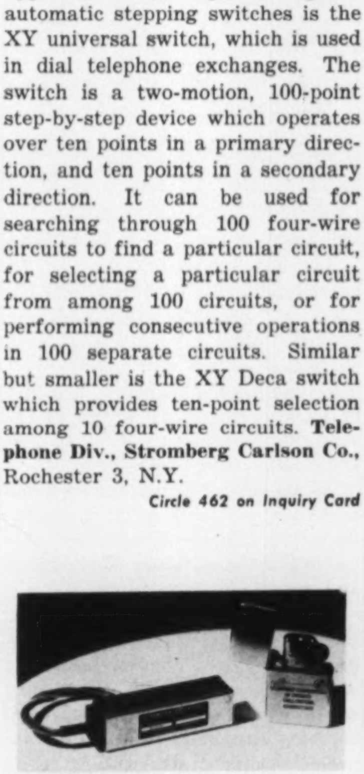
Circle 461 on Inquiry Card



Stepping Switches

Several types of stepping switches, originally designed for service in telephone systems, are available for automatic industrial applications. Principal among the automatic stepping switches is the XY universal switch, which is used in dial telephone exchanges. The switch is a two-motion, 100-point step-by-step device which operates over ten points in a primary direction, and ten points in a secondary direction. It can be used for searching through 100 four-wire circuits to find a particular circuit, for selecting a particular circuit from among 100 circuits, or for performing consecutive operations in 100 separate circuits. Similar but smaller is the XY Deca switch which provides ten-point selection among 10 four-wire circuits. **Telephone Div., Stromberg Carlson Co.,** Rochester 3, N.Y.

Circle 462 on Inquiry Card



Sealed Relay

Possibility of contact contamination is eliminated in new relay which has hermetically and individually sealed contacts. Model F-70334-1 relay uses Revere magnetically operated, hermetically sealed Glaswitch as the switching element which is isolated from all other parts of the unit.

Relay is available with coils designed for use at 6, 12, 24 or 48v dc. Contacts are normally open or normally closed, and are rated at 0.5 amp inductive, or resistive at 28v dc. **Revere Corp. of America,** Wallingford, Conn.

Circle 463 on Inquiry Card

he HAD to use a hand driver!

but YOU can use a Buckeye Air Tool!

Why AIR Tools?

Because air is everywhere, just waiting to be put to work . . . because continuous operation can't possibly harm an air tool . . . and because, if you're using Buckeye air tools, you can almost forget about tool maintenance.

In Air Tools, Your Best Buy Is Buckeye

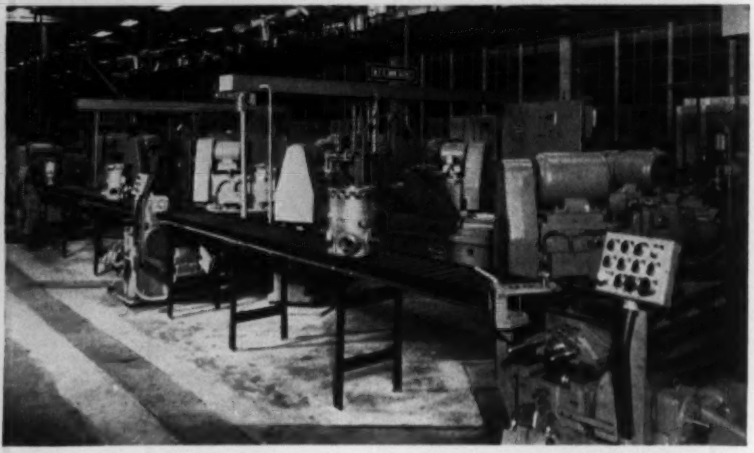
Ever drive a screw with one finger? You can—with a Buckeye air-powered screwdriver. Just press the throttle and the job is done—instantly. You can drive ten screws this way in the time it takes to drive just one by hand. What's more, you won't burr the screw head or damage the workpiece.

Your assembly methods should be as modern as your product. They're not, if you're using manual methods, or even if you're using outmoded power tools. Our Catalog A-10, if you haven't seen it, discloses some very helpful information about modern assembly methods and Buckeye tools. May we send you a copy?

Buckeye Tools
CORPORATION
DIVISION 12 • DAYTON 1, OHIO

Circle 601 on Inquiry Card

Ask Standard *how to cut costs with conveyors*



Standard gravity roller conveyors like this are modest in cost, easy to install and maintain.

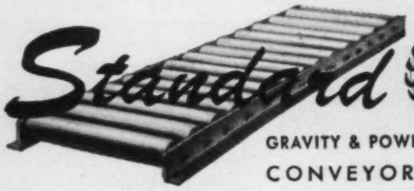
Conveyor system helps Airtemp up compressor parts production 40%

To handle stepped-up demands for residential and industrial air conditioners, the Airtemp Division of the Chrysler Corporation undertook an extensive re-tooling program. On one compressor crankcase line, for example, they installed 17 new machine tools . . . connected them all with Standard gravity roller conveyors. Result — two hours saving per case, production up 40%.

If you're planning on modernizing or retooling it will pay you, too, to find out how Standard conveyors can complement new equipment . . . give you lower overall costs and greater productive efficiency. STANDARD CONVEYOR COMPANY, North St. Paul 9, Minnesota. Sales and Service in Principal cities.

To expedite shipping or stocking and reduce handling costs, investigate Standard lightweight portable roller conveyors (right) or the portable, self-powered HANDIBELT conveyor (left), which can be used horizontally or at varying incline or decline angles.

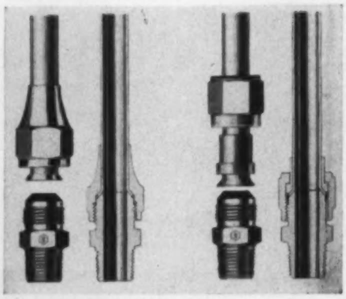
For details — contact the Standard representative listed in the classified phone book or write direct. Ask for Bulletin EE-2.



Standard GRAVITY & POWER CONVEYORS

50 years of conveyor experience

Circle 602 on Inquiry Card



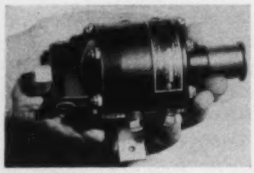
Tube Fittings

Two types of fittings, two and three-piece, are offered in Flare-Twin line of 37-degree steel tube fittings. Both offer the same range of applications—oil, water, steam and hydraulic systems. However, the three-piece (with sleeve in addition to nut and body) offers installation advantages while the two-piece offers a price advantage.

The line has also been expanded to include straight-thread type fittings for use with the SAE approved O-ring boss design. Such connection withstands higher operating pressures without the use of backup rings. All styles in the straight-thread type fittings are protected with Weathercote, a black phosphate finish for rust and corrosion prevention. It fully resists the effects of nonflammable hydraulic fluids, water base fluids, and petroleum base fluids.

The fittings are made in a full range of styles including connectors, unions, elbows, tees, and in sizes 1/8 to 2 inches. They may be used with soft steel tubing, and copper, aluminum and fully annealed stainless steel tubing in all normal wall thicknesses. **Weatherhead Co., Fort Wayne Div.,** 128 W. Washington, Fort Wayne, Ind.

Circle 464 on Inquiry Card

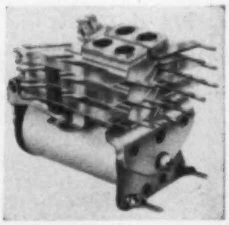


Pressure Transmitter

Model 200TD fixed range differential pressure transmitter makes possible the cost accounting of formerly unchecked sources of steam, water and air in departmental consumption. The device can be used to control plant process conditions such as liquid level or consistency and low pressure air or gases (up to 10 psi) requiring sensitive transmission readings to an indicating or recording instrument.

The transmitter measures 3 by 6½ inches, weighs 4½ lb and can be pipe mounted. All connections are ¼-inch NPT. Maximum working pressure is 150 psi, and temperature is 150F. Air supply pressure is 20 psi, air consumption is 0.10 standard cu fpm. Output pressure range is 3 to 15 psi. Calibration accuracy varies less than 1 per cent. Ranges are 0 to 50, 100, 200 and 300 inches of water. **Taylor Instrument Cos.,** 95 Ames St., Rochester 1, N.Y.

Circle 465 on Inquiry Card



Switching Relay

Available with printed circuit terminals, Type 8 relay is well suited for switching current loads. Printed circuit terminals are offered with standard twin-contact springs which have been widely used for reliability in switching circuits, with single - contact springs, or power type contacts for switching large current loads. For low-level loads, gold alloy or other special contact materials are available.

Terminals are tinned for ease of soldering and for ready insertion into the circuit board. They are ribbed for added strength, fully supporting the relay and eliminating mounting screws. Terminals for the contact springs are spaced for maximum clearance but do not exceed standard dimensions of the Type 8 relay. Coil terminals are located on the same centers as on the standard relay and dual coils employing four coil terminals are available. **Phillips Control Corp.,** Joliet, Ill.

Circle 466 on Inquiry Card

ARTER JIGMATIC
WILL DO *all*
YOUR POSITIONING
AND *do it fast*

ARTER

TAPE-CONTROLLED
AUTOMATIC
POSITIONING TABLE

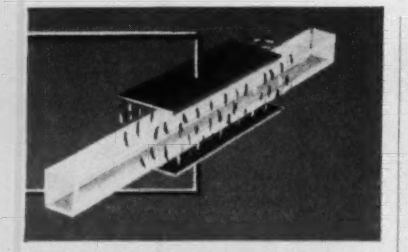
Check These Features...

- No stops
- No gauge rods
- Only SECONDS to change tapes
- MINUTES to set up
- No more than 11 tape holes to punch per position
- 600,000,000 possible positions. Hundreds of positions per single set-up
- Automatic magnetic locking
- Accuracy — plus or minus .001"
- Unidirectional approach at minimum speed
- Simultaneous operation of both coordinates

The 20"x30" ARTER has them all

ARTER GRINDING MACHINE COMPANY
WORCESTER 5, MASSACHUSETTS
Jigmatic Automatic Tape Controlled Positioning Table • Rotary Surface Grinders
Flat Circular Cutter Grinders • Internal Grinders • Cylindrical Grinders • Carbide Tool Grinders
AGENTS IN INDUSTRIAL CENTERS OF UNITED STATES AND CANADA

Circle 603 on Inquiry Card



RCA POWER TUBES
FOR
High-Efficiency Electronic Heating

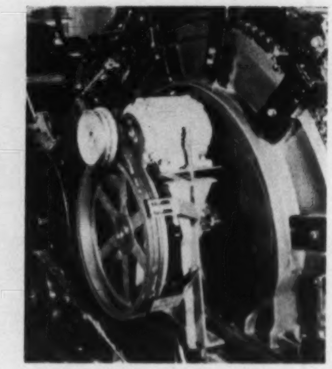
For long-term power delivery in dielectric- and induction-heating equipment, RCA offers industry an established group of electron power tubes for heavy-duty service. RCA tube design, associated with high-efficiency circuits, is your assurance of maximum power output—*around the clock*. Conservative ratings provide remarkably low tube cost per hour of equipment operation.

RCA Power Tubes are available in a wide choice of power ratings and frequency ranges. For prompt delivery on RCA power types, call your RCA Industrial Tube Distributor.

FREE TUBE GUIDE
24-page data booklet (PG-101-C) on RCA power tubes, rectifiers, thyratrons, ignitrons, magnetrons, vacuum-gauge tubes. Write RCA Commercial Engineering, Section B 85T, Harrison, N. J.

TUBES FOR INDUSTRY
Radio Corporation of America
Tube Division Harrison, N. J.

Circle 604 on Inquiry Card

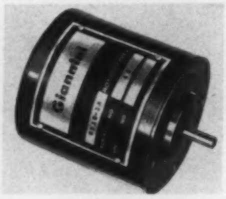


Card Drive

Designed to give a soft start to the heavy inertia textile card mechanism, card drive is built around Flexidyne, the dry fluid drive. The card drive makes possible a smooth start for a card which has a heavy inertia load, and accelerates the card to full running speed within 30 seconds without excessive strain on either the motor or card.

The unit also protects against excessive current draw during the starting period, and permits the use of a normal rather than a high-torque motor. It can also be run in reverse for stripping the card. The unit consists of a Flexidyne which is keyed to the motor shaft, a pedestal supporting the motor on which the Flexidyne is mounted, a V-flat drive from the Flexidyne to the card shaft, an aluminum stripper pulley mounted on the outer end of the Flexidyne housing, and an aluminum guard covering the drive and V-belts. **Dodge Mfg. Corp.,** Mishawaka, Ind.

Circle 467 on Inquiry Card



Shaft Positioner

Designed for use in computer equipment, Model 8915 Rotostepper is an electromechanical shaft positioning device which provides controlled incremental shaft rotation of one 2-degree step per dc pulse. The unit finds a wide variety of applications in sequence switching, algebraic counting, or any system requiring reliable, accurate shaft positioning.

Rotation is unlimited clockwise or counterclockwise, and stepping speed is as rapid as 60 steps per second with torque output as high as 14 oz-in. Between pulses, shaft position is locked in an accurate shaft angle by a spring detent. Nominal input of 1 amp at 28v dc for a pulse duration as short as 10 milliseconds will accomplish one 2-degree step.

Operational control mechanisms available on standard models provide homing to a fixed reference position, automatic continuous stepping with the application of a steady dc voltage, and/or potentiometer output proportional to shaft position. **G. M. Giannini & Co. Inc.,** 918 E. Green St., Pasadena 1, Calif.

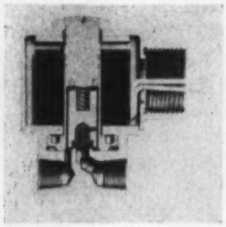
Circle 468 on Inquiry Card

Impulse Counter

Used for heavy duty operation where accuracy of count is required at high speeds, compact panel mounting electric impulse counter has a maximum counting rate of 40 per second, with electronic drives or electromechanical actuators and resistors in series. Shafts, wheels, and other parts are machined and of hardened steel, with driving parts hard chrome plated.

A reciprocating pawl actuation indicates when the counter is energized. Coils are rated for continuous duty. Reset to zero is by knob. Unit is designed for dc operation with coils from 6 to 220v. Model F 106HD is also available with one electronic decade for counting rates to 400 per second. **Presin Co.,** 12128 W. Pico Blvd., Los Angeles 64, Calif.

Circle 469 on Inquiry Card

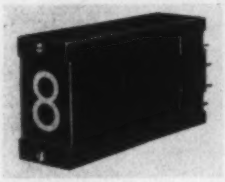


Solenoid Valve

Used for the control of air, water, oils, gasoline and many other fluids and gases, brass bodied solenoid valve weighs only 12 oz. Applications for the valve include welding equipment, lubricating devices and systems, spraying equipment, instruments, and automated machine controls.

The packless, direct acting device has only two moving parts; positive closing is assured by a spring return. The C-Series valve has orifices from 5/32 to 7/64-inch, with pressures ranging from 60 to 130 psi. **Skinner Electric Valve Div., Skinner Chuck Co.,** New Britain, Conn.

Circle 470 on Inquiry Card



In-Line Display

One-plane presentation in which all numbers and/or characters appear on the front surface of the device is a feature of in-line display unit. Numbers are of uniform size and intensity, insuring good readability. The digits, zero to nine, are 1¼ inches high and include a shifting decimal point.

Rated life of the lamps in the display is 3000 to 10,000 hours, depending upon the voltage used. Lamp replacement is made at the rear of the unit, assuring fast and easy maintenance. Single units available can be assembled in groups of two, three, four, etc., as required. The viewing screen extends the full width of the unit, so final assembly of a group presents a continuous surface. Overall size of the individual in-line dis-

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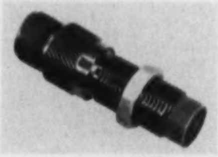
Circle 606 on Inquiry Card

play is 1½ inches wide, 2½ inches high and 5 inches deep. Voltage is 6 to 7.5v ac. **Industrial Electronic Engineers,** 3973 Lankershim Blvd., N. Hollywood, Calif.

Circle 471 on Inquiry Card

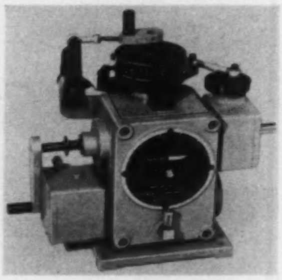


Power Pickup

Used as a self-generating power source for operating directly over and under speed controls or warning devices, power pickup is known as Model 3040. The unit provides sufficient power to operate low-voltage electrical devices without the use of an amplifier. Optimum load is 1000 ohm with 750 mh average pickup inductance.

At actuating surface speeds of 250 ips or more, the device provides sufficient power to operate relays having 100 milliwatt sensitivity. When using two germanium diodes in a voltage doubler circuit, the power pickup will operate a conventional 2500 ohm vacuum tube plate circuit relay. Power output can be increased at any low speed by placing enough capacity across the pickup, causing it to resonate at the frequency generated for the desired speed. **Electro Products Laboratories,** 4501 Ravenswood Ave., Chicago 40, Ill.

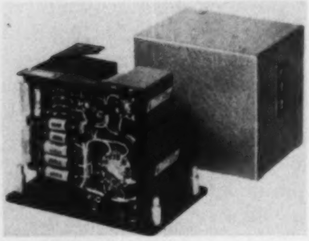
Circle 472 on Inquiry Card



Variable-Speed Unit

Adjustable over a complete range of 8 to 1, variable-speed transmission has settings which can be adjusted either automatically or manually while the unit is at standstill or in motion. Transmission components run in oil and are completely enclosed. Optional spur, bevel, or worm gear reductions are available and may be installed in any of four positions or planes. Transmission control is arranged by either electrical, mechanical, hydraulic or pneumatic means. Transmission of power is affected through multiple contact of driving and driven disks which are free floating on splined shafts equipped with only moderate axial loading. **George E. Clentimack Co. Inc.,** 229 West St., North Attleboro, Mass.

Circle 473 on Inquiry Card



Servoamplifiers

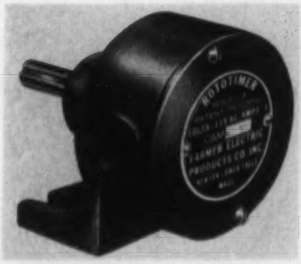
Used as components for the building block synthesis of automatic control loops, line of servoamplifiers for both 60 and 400 cps servomotors ranges in shaft power from 1 to 50w. The amplifiers have been designed with universal characteristics and flexible input circuits.

Four packaging styles are available, including hermetic sealing, and plug-in, quick disconnect packages. The input networks are arranged in three groups, for single-speed synchro and pot data, two-speed synchro data and dc data. Most amplifiers are completely self-contained, operating directly from the power lines. **Industrial Control Co.,** Wyandanch, L. I., N. Y.

Circle 474 on Inquiry Card

Synchronous Contactor

Designed to provide precise coordination of shaft position with electric circuit, synchronous contactor is called Model 3 Rototimer. The unit was developed to provide a synchronous switch for such applications as punch press control, magnetic counter actuation, shaft



synchronization, and register control. It is used primarily in applications where the operating point is carefully set and infrequently changed. This point of the switch is adjustable in 5-degree steps by resetting the cam. Fine adjustment is made by means of an eccentric screw that opens or closes the gap between the standard automotive distributor points. Contacts are rated 1 amp noninductive at 125v ac. **Farmer Electric Products Co. Inc.,** 2300 Washington St., Newton Lower Falls, Mass.

Circle 475 on Inquiry Card

Limit Switches

Used in machine tools, appliances, vending machines, aircraft and in-plant applications, Licon Type 30 enclosed limit switches are adaptable where safety factors require an enclosed or sealed switch. Versatility is afforded by interchanging components, three actuators and three housings, to form 16 types of switches. Actuators include a plunger, roller arm and roller plunger types.

The roller arm actuator has a micrometer screw adjustment which moves the arm through a wide arc in setting the trip point. When the switch trips, a slight additional turn is given to allow for overtravel, then the locknut is tightened. This method of setting the trip eliminates trial and error,

INEXPENSIVE—HIGHLY EFFICIENT

Cam Operated
4-Way Valve
Lever Operated
3 Position Valve
SERIES "CB"
Quick-As-Wink®
CONTROL VALVES
CONFORM TO J I C STANDARDS
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Spring Return Valve
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• These valves combine utmost simplicity, low price and rugged, efficient, dependable construction. Valve chambers* are formed by aluminum spacers held tightly in metal to metal end abutment assuring accurate positioning of the "O" rings on both inside and outside diameters without mechanical pressure. The flow is from the inlet chamber through the hollow radially ported ground and polished stainless steel plunger, and out through other ports in the plunger to the connected line. No direct impingement of flow across the packings. No lapped joints. No metal to metal seating. Sub-base permits ⅛″ or ¼″ pipe connections into either side or bottom. Easily serviced in the field. Write for fully descriptive bulletin.

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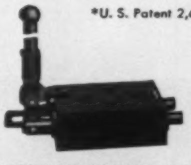

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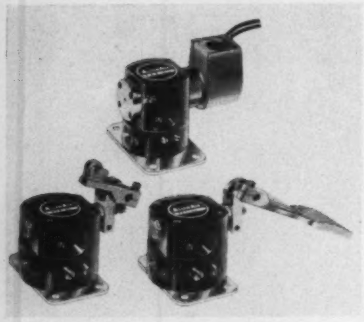
Circle 607 on Inquiry Card

prevents border-line operation and offers numerous trip positions. The roller arm can be turned to take positive and direct actuation from any direction. The roller plunger type actuator is adjustable through 360 degrees to take actuation from any direction, also. **Licon Switch & Control Div., Illinois Tool Works,** 2501 N. Keeler Ave., Chicago 39, Ill.

Circle 476 on Inquiry Card



Four-Way Air Valves

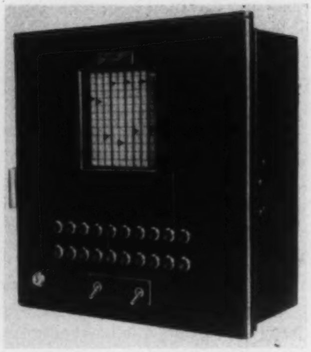
Available as single-solenoid, or for foot or cam operation, four-way air valves are an addition to a line of 1/4, 3/8 and 1/2-inch air valves. The single-solenoid valves are of the air-return principle and no springs are used in their construction. All friction surfaces are hardened and permanently coated with a baked-on lubricant.

Valves are designed for operation from 5 to 150 psi, and the solenoid models reciprocate at the rate of 800 strokes per minute. Two speed controls are built in to provide full control of the cylinder piston in both directions. **A. K. Allen Co.,** 57 Meserole Ave., Brooklyn 22, N.Y.

Circle 477 on Inquiry Card

Pyrometer Controller

Automatic temperature control of four to ten separate units is provided by multipoint pyrometer controller. The accuracy of a null balance potentiometer measuring circuit is combined with the speed of an electronic control system in this unit. The controller can be used with almost any installation suitable for two-position control action, including multizone ovens and furnaces, batteries of batch process units, etc.



In operation, a pulse timer and selector switch automatically connect thermocouples in sequence to the master control unit which compares each thermocouple voltage to its set point and energizes or de-energizes the corresponding load relay to the process unit. As a result, one instrument can provide accurate temperature control for installations that formerly required as many as ten instruments. The controller can be set to skip one or more points, providing optional control of a minimum of four and

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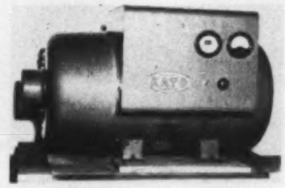
4" PITCH SPREADER
6" P
SECTION
TAKE-UP S

a maximum of ten units. Usual operating speed is 3 seconds per point, 30 seconds for all ten points. Many temperature ranges are available between −400 and 3250F for all standard thermocouple calibrations, and from −100 to 1600F for resistance bulbs. **Thermo Electric Co., Inc.,** Saddle Brook, N.J.

Circle 478 on Inquiry Card



Motor Generator Set

Designed to convert dc to ac, lightweight motor generator set was developed for many continuous hours of trouble-free operation. Both motor and alternator are encased within a common frame with single shaft, two ball bearing construction, thus eliminating a coupling and creating a compact unit.

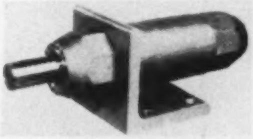
The machine operates at 1800 rpm. Generator ac output is 120v, one-phase, 60-cycle, 2500w. Dc motor is minimum voltage 27½v and maximum 29v. A Lee governor controls the motor revolutions per minute. Instrument panel includes frequency meter, ac voltmeter and input voltage control rheostat. **Kato Engineering Co.,** Mankato, Minn.

Circle 479 on Inquiry Card

Solid Lubricants

Line of molybdenum disulfide compounds which is designed to help solve difficult lubrication problems is called Molyglyde. One type of lubricant in the line, called #156-P, is a multiduty lubricant designed for general use (where heat above 300F is not a factor) in maintaining capital equipment and automated production lines. Another type is 256-V which incorporates moly in a volatile base. Applied in the same manner as a light viscosity lubricant, the moly is conveyed to points to be protected where it volatilizes, leaving the moly to function as a dry lubricant. Originally developed for the food and textile industries where contamination is a vital factor, type 256-V has applications in a variety of other fields. **VanGuard Solid Lubricants Inc.,** Dept. 3-A, 57 E. 73rd St., New York 21, N. Y.

Circle 480 on Inquiry Card



Impact Tool Attachment

Used on drill presses, special machines, arbor presses and other existing equipment, pneumatic impact tool attachment is designed for mounting at any angle. The unit simplifies marking for identification purposes and scrap control, light piercing, staking and riveting.

The device operates on line pressure as low as 20 lb and can be actuated electrically by solenoid or manually by poppet valve. The attachment has only one moving part, assuring long life and trouble-free operation. **Air-Impac Co.,** 920 Walnut, Flint 1, Mich.

Circle 481 on Inquiry Card

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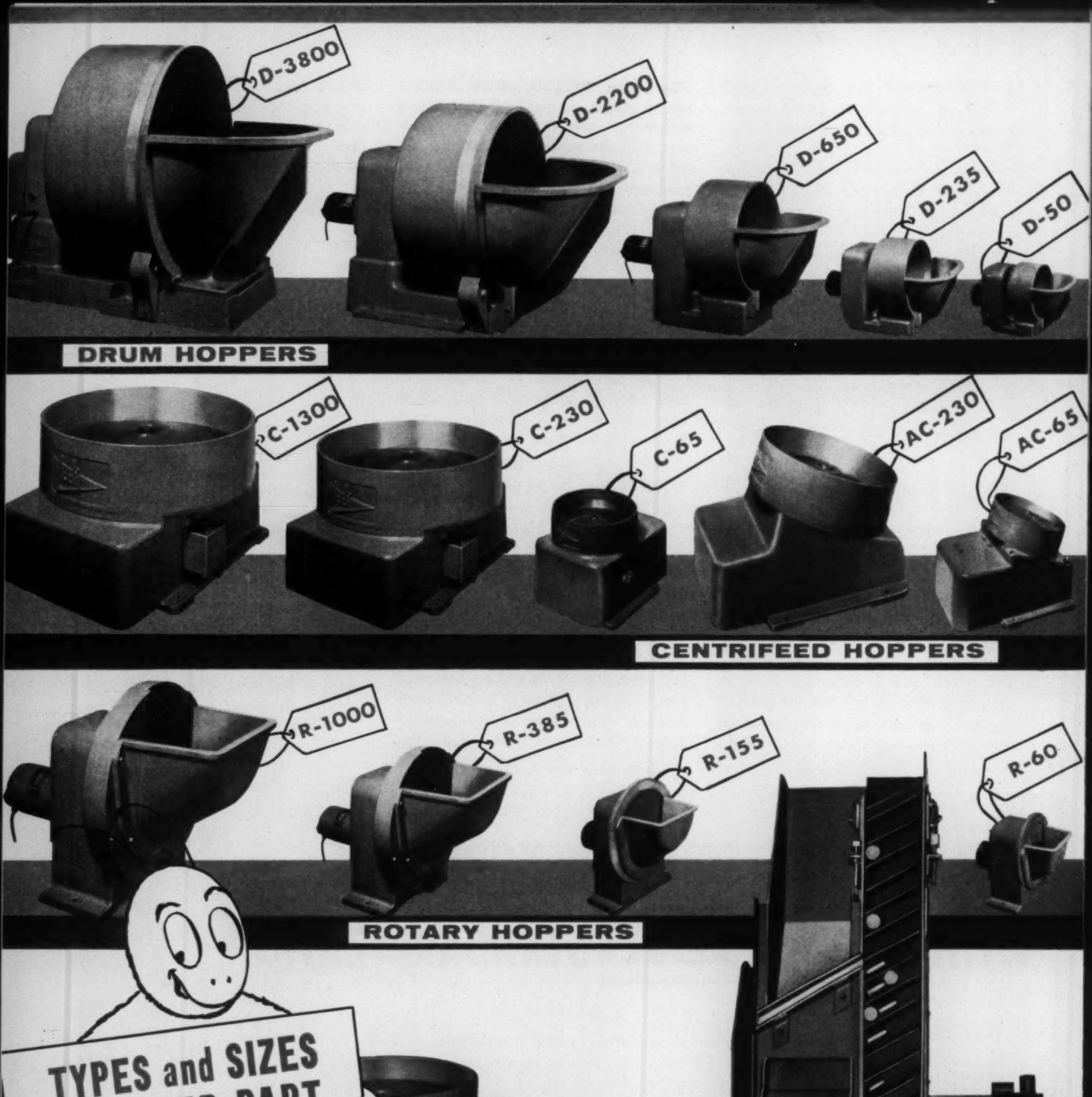
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catalogs and literature

Latest automation information. For copies use card page 17.

Static Control Elements

General Purpose Control Dept., General Electric Co., Bloomington, Ill.—8-page bulletin—Method of electrically controlling machine functions by the use of logic elements and accessories that are not subject to wear and erosion is discussed in bulletin GEA-6578. Static control elements, whose life expectancy is independent of the number of operations, convert a combination of inputs into a single output by controlling the impedance of an output coil on a magnetic core. Brief explanation of fundamentals of static control, operating characteristics and installation data are included.

Circle 482 on Inquiry Card

Submerged Arc Welders

Lincoln Electric Co., Cleveland 17, *O.—20-page booklet*—Designed for automatic ac and dc welding, line of submerged arc welders is described and illustrated in booklet. Special attachments, such as vertical head adjuster, contact nozzle and jaw assembly, and controls to permit tandem and side by side welding, are illustrated. Available power sources are also covered.

Circle 483 on Inquiry Card

Press Modernization

Fawick Airflex Div., Fawick Corp., 9919 *Clinton Rd., Cleveland* 11, *O.*—15-*page bulletin*—Application photographs and selection guides for press modernization packages are included in Bulletin ML-172. Packages include CB Airflex clutches, CS brakes, Timing Rotorseals, high-speed clutch controls and flywheels mounted on antifriction bearings.

Circle 484 on Inquiry Card

Infrared Analyzers

Leeds & Northrup Co., 4934 *Stenton Ave., Philadelphia* 44, *Pa.*—8-*page bulletin*—Discussion of the application of infrared equipment to monitor CO, CO_2, or CH_4 content of metallurgical atmospheres is given in Folder N-91-620(1). A description of continuous measurement of these gas components from the output of endothermic or exothermic generators or in the furnace itself is given. Typical chart records and schematic diagrams of equipment are included.

Circle 485 on Inquiry Card

Machine Leveling Jacks

Enterprise Machine Parts Corp., 2731 *Jerome at McNichols Rd., Detroit* 12, *Mich.—4-page pamphlet*—Developed to provide dependable support and positive leveling adjustment for production machines, special machinery, industrial furnaces, etc., line of leveling jacks is the subject of illustrated bulletin. Photographs and specifications of two models are included, along with data on vibration absorbing mounting pads for use with the jacks.

Circle 486 on Inquiry Card

Photoelectric Controls

Autotron Inc., Box 722-*RR, Danville, Ill.—16-page booklet*—Designed for use in automatic counting, sorting, weighing, bin level and safety controls, plus other automatic control applications, photoelectric devices are the subject of booklet. Types covered include photoelectric controls of moderate to ultra sensitivity, high speed and impulse actuated units, photoelectric timing controls and electronic timing controls. A variety of components is illustrated and briefly described. Sketches of several applications are included and application pointers given.

Circle 487 on Inquiry Card

Weighing Systems

A. H. Emery Co., Pine St., New Canaan, Conn.—12-page bulletin—Various arrangements for tank and bin weighing systems are illustrated and described in Bulletin 561. Controlling, recording and indicating instruments for use with the weighing systems are pictured. Systems are well suited for controlling quantity in automatic operations.

Circle 488 on Inquiry Card

Slide Feeds

Cooper Weymouth Inc., 277 *Noble Ave., Bridgeport* 8, *Conn.—4-page pamphlet*—Used in automatic punch press operations, line of slide feeds is described in illustrated pamphlet. Stock control units for the slide feeds include a stock drag, a stock check, and combination check and drag. Features of the feeds are briefly described and components are pictured.

Circle 489 on Inquiry Card

Humidity Instruments

Bristol Co., Waterbury 20, *Conn.*—22-*page booklet*—Information on indicating, recording, and automatically controlling wet and dry bulb instruments and psychrometers is included in Bulletin H1009. Models for permanent mounting in various types of installations, as well as portable models, are described. Wet bulb fixtures, valves and motor operators for louvers, ducts, etc. are among the accessories covered.

Circle 490 on Inquiry Card

Tube Fittings

Lenz Co., Box 1044, *Dayton* 1, *O.*—4-*page pamphlet*—Used on air, refrigerant and hydraulic systems, line of O-ring tube fittings is described in pamphlet. Illustrated models include male and female connectors, male and female branch tees, elbow union, etc. Specifications of each type are given.

Circle 491 on Inquiry Card

Vibration and Noise Control

Korfund Co. Inc., 48-15 32*nd Place, Long Island City* 1, *N.Y.—8-page bulletin*—Actual installation photographs illustrate group of case histories which describe the use of vibration and noise control machinery mountings. Bulletin K7A includes an explanation of the theory and purpose of machine tool vibration control and discusses use of vibration controls without bolting machines to floor.

Circle 492 on Inquiry Card

Control Valves

Atlas Valve Co., 280 *South St., Newark* 5, *N.J.—8-page bulletin*—Automatic pressure, temperature and level control valves for automatic process control are described in Bulletin 56C. Control devices which are

←Circle 609 on Inquiry Card

briefly discussed and illustrated include reducing valves, pump governors, relief valves, temperature regulators, float valves, and combustion control valves for heating, power generation, chemical processing and other industrial applications.

Circle 493 on Inquiry Card

Rubber Mounted Bearing Units

Sealmaster Bearings Div., Stephens-Adamson Mfg. Co., Aurora, Ill.—4-page pamphlet—Designed to reduce noise and vibration on light duty applications, rubber mounted bearing units are the subject of Bulletin 1253. Photographs and specifications of the units in pillow block, flange unit and cartridge unit types are included.

Circle 494 on Inquiry Card

Positioning Systems

Farrand Controls Inc., 4401 *Bronx Blvd., New York* 70, *N.Y.*—12-*page bulletin*—Used for automatic positioning control and numerically controlled contour machining for large drill presses, boring machines, milling machines, grinders, jig borers, gear cutters and lathes, Inductosyn linear micropositioning system is described in Bulletin No. 819. Also covered is the rotary type Inductosyn which can be used as an electromechanical dividing head, a data transmission system or a precision position servo. Photographs and application data are included.

Circle 495 on Inquiry Card

Contact Meter-Relays

Assembly Products Inc., Chesterland 1, *O.*—40-*page catalog*—Indicating meters with built-in relay contacts which are used for automatic control are described in Catalog No. 4A. Current and voltage sensitive relays, automatic temperature control units, bearing monitors, panel meters and pyrometers are also illustrated, and their specifications given. Diagrams and discussion of different available types of circuitry are also included.

Circle 496 on Inquiry Card

Rugged Long-Life Tubes

State Labs Inc., 649 *Broadway, New York* 12, *N. Y.*—72-*page catalog*—LM Ericsson line of ruggedized, long-life miniature electronic tubes is described in comprehensive catalog. Line is produced by Swedish manufacturer operating under Western Electric and other licenses who is well known as a supplier of telephone equipment. Line is said to be the only commercial source on many important Western Electric types. Triodes, RF pentodes and power amplifier pentodes are covered, with detailed data sheets included.

Circle 497 on Inquiry Card

Pulse Control Testing

Burroughs Corp., Electronic Instruments Div., 1209 *Vine St., Philadelphia* 7, *Pa.*—16-*page booklet*—Capable of testing tape wound or ferrite cores, pulse control systems are described in Tech. Bulletin 136. Factors to be tested, levels of testing and the pulse control method are discussed. Diagrams illustrate four different testing patterns.

Circle 498 on Inquiry Card

Power Transmission Machinery

Dodge Mfg. Corp., Mishawaka, Ind.—328-*page catalog*—Bearings, couplings, speed reducers, bushings, and v-belt drives are among the power transmission machinery covered in engineering catalog D56. Sectional drawings, dimensions, weights, prices, application details and engineering tables are included. Eight-page index provides easy reference to all material in the catalog.

Circle 499 on Inquiry Card

Instrument Panels

Bailey Meter Co., 1050 *Ivanhoe Rd., Cleveland* 10, *O.*—16-*page booklet*—Six standard designs of instrument and control panels for power and process plants are illustrated and described in Booklet G71-7. Among types covered are vertical single panel, vertical duplex panel, bench front single and duplex panel and control desk. Specifications; supports for tubes, wires and equipment; standard mountings and dimensions of the units are included.

Circle 500 on Inquiry Card

Fluid Drives

American Blower Corp., Detroit 32, *Mich.*—16-*page booklet*—Designed for ½ to 25 hp applications, Gyrol fluid drives are the subject of Bulletin 9119. Types T, TM and VS Class 2 are illustrated and described. Typical performance curves compare starting torque, starting current and heat generation characteristics of an ac motor direct-connected to a load with those of a similar motor using a Gyrol fluid drive. Photographs, specifications and performance data are included.

Circle 501 on Inquiry Card

Sectional and Unit Valves

Commercial Shearing & Stamping Co.—1775 *Login Ave., Youngstown* 1, *O.*—96-*page catalog*—Used to control fluid power in the operation of cylinders and motors, line of control valves is the subject of Catalog H-12. Models of directional control valves furnished in sectional and unit types are described. Varieties of inlet, working and outlet sections are illustrated and can be combined to give desired valve configurations. Performance data, capacities, types, sizes and mounting dimensions are covered; illustrative material includes photographs of typical installations, cutaway drawings, and flow schematics.

Circle 502 on Inquiry Card

Precision Switches

Haydon Switch Inc., Waterbury, Conn.—12-*page bulletin*—Used in aircraft, industrial and commercial applications, line of precision switches is described in Catalog No. 5. Hermetically sealed switches, subminiature switches, standard single-blade and double-blade types, and standard and special actuators are covered. Electrical specifications and schematic drawings are included.

Circle 503 on Inquiry Card

Strip Thickness Control

Industrial Nucleonics Corp., 1205 *Chesapeake Ave., Columbus* 12, *O.*—12-*page bulletin*—Uses for line of strip thickness control systems on tandem cold mills, reversing cold mills, zinc and tin coating lines, classifying and assorting lines and nonferrous applications are shown in Bulletin #B1556. Application photographs are included, along with illustrations of production analyzers, automatic electronic controllers and classifying units.

Circle 504 on Inquiry Card

Magnetic Conveyor-Elevator

Eriez Mfg. Co., Erie, Pa.—2-*page pamphlet*—Automatic parts conveying of such ferrous objects as nuts, bolts, nails, spikes, stampings, metal parts, cans, caps, etc. is performed by permanent magnetic conveyor-elevator described in pamphlet B-86-1. Specifications, application photographs and design features of conveyor-elevator are covered.

Circle 505 on Inquiry Card

Photoelectronic Edge Guidance

Intercontinental Dynamics Corp., 170 *Coolidge Ave., Englewood, N.J.*—4-*page pamphlet*—Automatic device which provides precise control of the edge register of moving material is described and illustrated in pamphlet. Called the Edgetrol, the unit is used for positioning in printing, tubing and rerolling, slitting and punching, tentering, intersheeting and manifolding.

Circle 506 on Inquiry Card

Coolant Supply Systems

Sealol Corp., Warwick Industrial Park, Providence 5, *R.I.*—4-*page pamphlet*—Designed for use in deep hole and precision drilling, high pressure coolant supply unit is illustrated and described in Bulletin 17. Used in conjunction with a Sealol drill adaptor, the unit forms part of a system which delivers clean coolant through a drill at high pressure and in proper volume, directly to the cutting edge of the tool.

Circle 507 on Inquiry Card

Precision Ball Bearings

Barden Corp., Danbury, Conn.—*64-page handbook*—Used in instruments, synchros, motors, generators, servomechanisms, computers, recording devices, etc., line of precision ball bearings is the subject of comprehensive handbook. Dimensional index, series index and a visual guide to bearing types, characteristics and applications, as well as a separate index to selection and engineering data, facilitate reference to points of interest. Torque, static, and dynamic data are given in chart and table form, with cutaway drawings and cross-sectional illustrations also included.

Circle 508 on Inquiry Card

Variable Speed Drives

Worthington Corp., Advertising & Sales Promotion Dept., Harrison, N.J.—*8-page bulletin*—Line of variable speed drives with positive pulley adjustment is the subject of Bulletin #1610-B1 P. Selection of the drives for any specialized requirement, engineering features, remote controls, separate motor drive and mechanical power transmission products are covered. Illustrations of several motor drives are included.

Circle 509 on Inquiry Card

Overhead Handling

Whiting Corp., Harvey, Ill.—*8-page bulletin*—Designed to provide speed and versatility for handling in receiving, assembly, shipping or storage, overhead crane or monorail systems called Trambeam are the subject of Bulletin M-25. Carriers for both bridge and runway ride the lower flange of the supporting beam in contrast to top-running overhead cranes. Features of system are discussed and application photographs are included.

Circle 510 on Inquiry Card

Self-Aligning Roller Bearings

Link-Belt Co., Dept. PR., Prudential Plaza, Chicago, Ill.—*8-page bulletin*—Used in the fields of construction, oil, and heavy industrial equipment, line of self-aligning roller bearings is described in Book 2658. Three types are covered: Series S adjustable single-row self-aligning roller bearings, Series D adjustable double-row bearings, and Series M preadjusted double-row self-aligning bearings. Selection data, dimensional specifications and recommended fitting practices are included.

Circle 511 on Inquiry Card

Electronic Tube Selection

Tube Dept., General Electric Co., One River Rd., Schenectady 5, N. Y.—*4-page pamphlet* — Selection chart which lists high reliability tubes for critical applications is designated ETD-1276. Chart classifies 34 tubes, applicable military specifications, heater voltages and currents and gives average characteristics.

Circle 512 on Inquiry Card

Automatic Plating

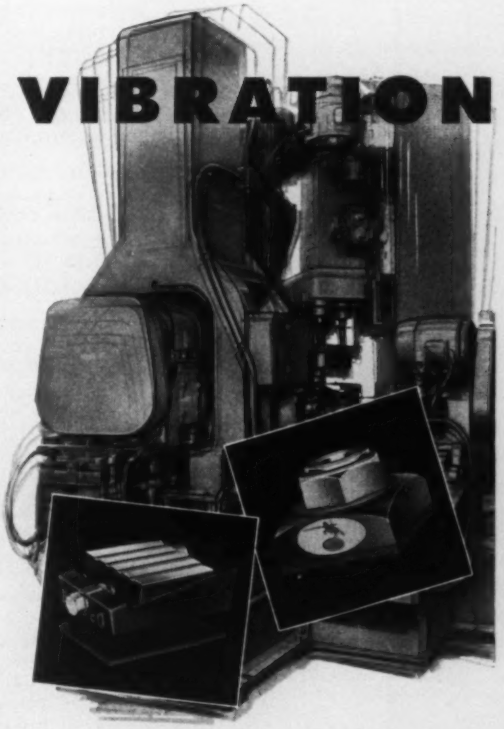
George L. Nankervis Co., 19255 W. Davison Ave., Detroit 23, Mich.—*4-page pamphlet*—Completely automatic plating plant for automobile bumpers is described and illustrated in pamphlet. Photographs illustrate the two-floor installation, circulation of the plating solutions, unloading, filtration and ventilation of the system.

Circle 513 on Inquiry Card

Rubber Squeeze Rolls

Rodney Hunt Machine Co., Orange, Mass.—*2-page pamphlet*—"Effect of Linear Pressure on Rubber Covered Squeeze Rolls" is the title of Engineering Report No. 9, directed to roll using industries such as the textile, paper, plastics, rubber, metalworking etc. Report assists in the design, selection and use of rolls for specific plant applications.

Circle 514 on Inquiry Card



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AUTOMATION abstracts

CREATIVE PRODUCTION ENGINEERING

By W. P. SMITH
Assistant Professor of Mechanical Engineering
Michigan State University

PRODUCTION-ENGINEERING as it is generally known today is a relatively recent addition to the structure of industrial organizations. Of course, the problem of deciding how work should be performed has always been present. At one time all decisions relative to work methods and machine and tool selection were made by the workman or machine operator. As long as the workman was in a position to make decisions that seemed satisfactory regarding these matters and as long as his decisions had little or no effect on the methods, machines, and tools of surrounding workmen, this procedure was certainly efficient and also satisfying to the workman.

As machines and tools become increasingly complex and each work station becomes more dependent on all the others, the necessity for a group of specialists to plan methods, select machines and design tools and handling systems becomes more apparent. In the face of technological advances and the ever greater pressure imposed by the consumer for better products at lower prices, the need for creative engineering analysis and design applied to the problems of producing goods should be even more obvious. Many roadblocks stand in the path of this goal. Revealing some of the roadblocks that impede production - engineering progress, and an introduction to some of the ways of surmounting them is the purpose of this paper.

These major problems must be faced by the production engineer: (1) Organizational conflicts and inefficiencies, (2) better production engineering specifications, (3) creative development of alternative production plans and processes, (4) better analytical tools to study the behavior of production plans and processes, (5) development and training of production-engineering personnel of high caliber.

Organizational Conflicts

Engineering is essentially concerned with design. Engineering activity results in specifications which are given to manufacturing. There are three essential sets of specifications needed by manufacturing in order to satisfy the customer fully:

The product design specifications which describe with words, pictures, symbols, etc., the size, shape, weight, volume, strength, surface finish, and other physical and chemical characteristics of the product.

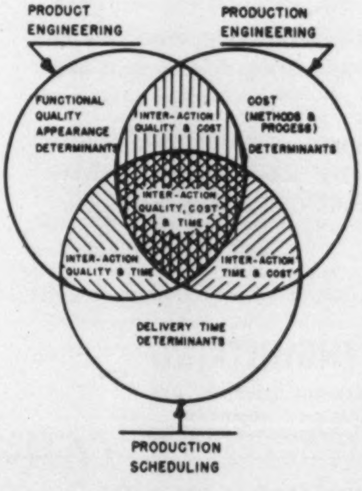
PRODUCT ENGINEERING
PRODUCTION ENGINEERING
FUNCTIONAL QUALITY APPEARANCE DETERMINANTS
INTER-ACTION QUALITY & COST
COST (METHODS & PROCESS) DETERMINANTS
INTER-ACTION QUALITY, COST & TIME
INTER-ACTION QUALITY & TIME
INTER-ACTION TIME & COST
DELIVERY TIME DETERMINANTS
PRODUCTION SCHEDULING

Fig. 1—Functional subdivision of the total engineering job.

These are the specifications that establish the purpose of the product or the job the product will do, as well as the quality of the product and what the product will look like.

The production design specifications which describe with words, pictures, symbols, etc., the machines, tools, operators, space, motion patterns, etc. required to produce the product. In effect these are the specifications that establish the methods of manufacturing the product and to a great extent the cost of manufacturing the product, and the price the customer must pay.

The manufacturing schedule specifications which describe with words, pictures, symbols, etc., when various steps in the manufacturing procedure should be carried out during the day, hour, month, etc.

These are the specifications that determine when the product will be ready for delivery.

It would appear reasonable, if the total engineering activity must be subdivided at all, that a division based upon the three major types of specifications required in manufacturing would be a logical means of subdivision. The production engineering subfunction would then contain all of the work involved in specifying the methods of manufacturing the product. It would contain all of the following activities: (1) Process engineering and routing, (2) methods engineering and motion study, (3) tool design, (4) materials handling system design, (5) plant-layout design, (6) time study and work measurement, (7) machinery-replacement analysis, (8) process and methods research and development.

The fact that in many manufacturing plants these duties are scattered throughout the organiza-

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tion accounts to a great extent for the conflicts and inefficiencies that exist. It is no wonder that so many conflicts exist when, in a typical plant, plant layout and materials-handling design are performed under the man in charge of maintenance, while the process engineer reports to the chief engineer, the time-study engineer works for a chief industrial engineer, but the machinery-replacement analysis is under the accounting department. Here is a typical situation where a group of people are all working toward the common objective of establishing the method of manufacturing the product, but are organizationally unrelated. It is amazing in situations like this that a production routing ever gets established.

In many of the more mature and efficiently operating organizations steps are being taken to bring these related duties back under one roof. This trend has been apparent over the past 5 years and will doubtless continue.

It is essential at this point, to introduce another obvious concept. It pertains to the interdependent nature of the three design areas, *Fig.* 1. Each total engineering plan must attempt to be an optimum balance in terms of what the customer wants. Product design can and does dictate essential characteristics of the production-methods design and the schedule design. On the other hand production-methods design can and does dictate essential characteristics of the product design and the schedule design. Each design area imposes certain limitations on the others. Each resulting plan whether it is a drawing, or a production routing, or a schedule is always a compromise that attempts to meet all of the customer's objectives simultaneously.

If these design areas do conflict as they obviously do, it would appear that they should have equal organizational stature. In practice this is seldom true. Product research, development, and design generally take precedence over the other two design areas. This is only natural since engineering methodology has been applied for a longer period and in a more rigorous manner to product design than to the other design areas. It is also true that the product design must be partially conceived prior to production methods design and schedule design. Nevertheless, lack of organizational stature is the source of another retardant to production-engineering growth and creative development.

Production Specifications

The common methods of conveying production - engineering plans are: (1) Production routings (for each part), (2) operation instruction sheets (for individual manufacturing operations), (3) tool drawings, (4) time-study record sheets (for individual manufacturing operations), (5) plant-layout drawings or models.

One method of evaluating a production - engineering specification from the standpoint of transmission efficiency would be to compare it with another type of engineering specification; namely, the product-design specification. In most manufacturing organizations this specification would involve a series of part drawings and assembly drawings for the product. The efficiency of these drawings from a communications viewpoint could be checked by sending them out to various parts of the country and requesting that a product be constructed according to these specifications. When these products were completed, they could be measured, analyzed, and tested according to the original product-design specifications. It would be surprising to find major dimensional or other quality discrepancies between these products, manufactured under varying conditions in different parts of the country. This would lead one to believe that product-design specifications in use today are relatively efficient. At least the message gets through and without too much distortion.

A similar experiment could be set up to test production-engineering specifications. They could be sent with the drawings to various parts of the country. Motion pictures could then be taken in each plant and an exact record could be made of the actual methods used and the time required. From these data accurate costs could be developed. Discrepancies in method, time, and cost would indicate areas where the production-engineering specifications fell short of efficiently communicating the production-engineer's intent. It doesn't require a great deal of imagination to picture the discrepancies that probably would occur.

The possibility of programing machines by punched tape or computers is giving rise to some interesting attempts to symbolize and standardize production-engineering instructions in a manner that promotes reliable communication. The need is increasingly apparent when the man-machine network becomes more complex.

Photographic techniques offer great possibilities for recording established methods. The recent development of extremely sensitive film, eliminating the need for lights and other awkward gear, should accelerate these applications. As competition for the customer's dollar becomes more intense, it will become necessary to predict the outcome of production-engineering plans with greater accuracy. Methods specifications cannot be left to chance. They must be speci-

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fied, and specified clearly, in a language that is universally recognized. This certainly calls for standardization of the symbols and notations used to describe processing plans far beyond anything we now know.

Alternative Production Plans

Many production engineers, when presented with a manufacturing problem, jump immediately to a preconceived notion of the best solution. Too many problems are solved primarily on the basis of some previous experience that seems similar. A more logical procedure is needed that seeks out the basic factors underlying each problem, attempts to establish problem objectives, and means of quantifying and measuring results. This procedure should, if possible, have a built-in mechanism that would uncover all possible alternative solutions so that they could be evaluated properly. A suggested procedure is outlined in *Fig.* 2.

Steps in the production engineering of a part are:

1. Make product analysis
   (a) Assembly chart
   (b) Functional requirements list
   (c) Critical conditions list
2. Select alternative forms of raw material.
3. Construct a work list containing all of the elements of work that are anticipated to be required to make the product according to specifications.
4. Indicate alternative groups of *unit processes* that are required to satisfy each element on the work list.
5. For each alternative, combine unit processes into *manufacturing operations*.
6. Arrange manufacturing operations into a logical *sequence*.
7. Evaluate alternative sequences of manufacturing operations.
   (a) Economic evaluation
   (b) Technological evaluation
8. Select the optimum solution.
9. Specify the details of the components required for each manufacturing operation.
10. Install the system.
11. Follow-up by observing whether or not the manufacturing operations behave as predicted. (Compare actual results against estimates.)
12. Adjust or change the system until the desired results are obtained.

There is a need for small process "building blocks" that would facilitate synthesizing a new process or describing what must be done to a product in order to produce it. A *unit process* is such a small process "building block."

A unit process is a modification of a product done without essential interruption.

The unit process does not tell what machine or other equipment is to be used in order to modify the product. It only indicates what the modification will consist of. Unit processes make it easier to check processes because their cost characteristics can be tabulated conveniently for ready comparison.

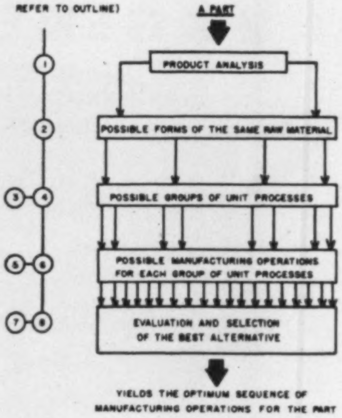

REFER TO OUTLINE)
A PART
1
2
3
4
5
6
7
8
PRODUCT ANALYSIS
POSSIBLE FORMS OF THE SAME RAW MATERIAL
POSSIBLE GROUPS OF UNIT PROCESSES
POSSIBLE MANUFACTURING OPERATIONS FOR EACH GROUP OF UNIT PROCESSES
EVALUATION AND SELECTION OF THE BEST ALTERNATIVE
YIELDS THE OPTIMUM SEQUENCE OF MANUFACTURING OPERATIONS FOR THE PART

Fig. 2—Development of processing alternatives.

Manufacturing a part consists of performing a group of unit processes on a piece of raw material until it conforms to product specifications (blueprints, material specifications, etc.) *Fig.* 3.

The procedure just outlined is an attempt to introduce a logical, creative approach to the problem of solving production-engineering problems. Thus far only the creative or design aspects have been discussed. It is now necessary to reach a decision and to select the best alternative from the many alternatives that have been developed. The problem of selecting the best alternative leads directly to the fourth roadblock facing production-engineering progress.

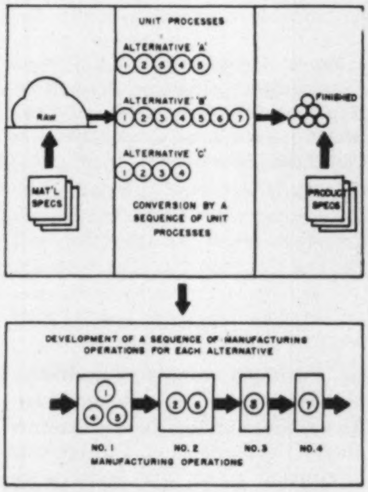
Better Analytical Tools

In an engineering group it would seem logical to expect ready acceptance of any and all mathematical tools. Certainly in most product-engineering groups the use of mathematics is apparent in all phases of research, development, and design work. It is disappointing to note the contrast in the production-engineering area where resistance rather than acceptance is often the rule. Attempts to quantify production-engineering problems are deemed impractical, unrealistic, and time-consuming. Rather than take advantage of gains made in other areas of knowledge, empiricism is the guiding light.

It is beyond the scope of this paper to delve into the many possible tools available to the competent production engineer. Other papers have presented specific examples illustrative of the mathematical approach. Certainly some of the most obvious avenues would include: (1) Probability theory—applications of risk analysis to the problem of deciding between alternative methods, (2) analysis of variance—to check on the relative effects and interactions of a number of variables on the outcome of a production plan, (3) matrix algebra and vector analysis—to select the course of action that minimizes lost time or maximizes profits, (4) differential equations—to study the transient-flow characteristics of various types of production systems.

Once the variables in any production system have been identified and their interrelationships equated it would be possible to utilize computers for the solution of production-engineering problems of amazing complexity in a relatively short time. Here again much can be learned from problems already solved by product engineers that are quite analogous to production-engineering problems. Many techniques have been developed using both analog and digital computers to study the behavior of electrical, mechanical, thermal, or hydraulic systems. What is so unique about a production system that it will not lend itself to the same treatment? In a production system there are components equivalent to the voltages, resistances, currents, pressures, temperatures, and impedances found in the other systems. If an electronic computer can be used to study traffic tie-ups in a busy city, why not production bottlenecks in a future factory?

Another approach to these complex problems is through the use of simplified working models and pilot plants. Long used in the chemical industry, the application of the same thinking in the mechanical industry has been rare. But when the fixed costs of a highly automatic plant become large and the risk of a wrong decision expensive, pilot-plant studies and models should become common practice. Perhaps the key to this roadblock rests in meeting the last retardant to creative production engineering.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1 2 3 4 5
RAW
ALTERNATIVE 'B'
1 2 3 4 5 6 7
FINISHED
ALTERNATIVE 'C'
1 2 3 4
MAT'L SPECS
PRODUCT SPECS
CONVERSION BY A SEQUENCE OF UNIT PROCESSES
DEVELOPMENT OF A SEQUENCE OF MANUFACTURING OPERATIONS FOR EACH ALTERNATIVE
1 4 5
2 6
3
7
NO. 1
NO. 2
NO. 3
NO. 4
MANUFACTURING OPERATIONS

Fig. 3—Concept of unit processes and manufacturing operations.

Development and Training

In order to realize fully the stature that the production-engineering function must have in the complex technology of the future, it will be necessary to develop and train personnel of high caliber. The barrier must be broken down that looks with some disdain on the researcher, the scientist, and the mathematician. These men must not be relegated to purely product-engineering problems. The problems of production planning

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and engineering, because of involved man-machine-material relationships, are so much more complex than those involving product design that the best brainpower available should be encouraged to tackle them. Research effort must be expended in this direction if major contributions are to be made.

In our engineering schools greater efforts must be made to raise the levels of our teaching particularly in the so-called shop or processing courses. Courses should be developed that utilize to the fullest possible extent the physics, mathematics, mechanics, and metallurgical backgrounds of the student engineer. The economics of processing must be introduced at an early stage with the same rigor and logical thought procedure as the fundamental courses in applied mechanics. Certainly courses that only teach the student how to run a machine or grind a tool bit are of marginal value to the production engineer of the future. He must be an accomplished statistician because his problems contain many interacting variables. He must have a fundamental understanding of psychology and biology since he must design systems containing human beings as well as machines.

It should be apparent that this job description can only be filled by highly analytical and creative people with engineering education of a high order. More of these people must be convinced that challenging job opportunities exist within the production-engineering domain if the fifth roadblock is to be hurdled.

From a paper entitled, "Steps Toward More Creative Production Engineering" presented at the ASME Semi-Annual Meeting in Cleveland, June 1956.

AUTOMATION IN ITALY

By Dr. Ing. Carlo Rossi
President
National Italian Association for Automation

RECENT PROGRESS of automation abroad has had a wide echo in Italy where this new economic trend has created considerable perplexity as to its possible social consequence. Such apprehensions, widely shared, could lead to certain policies and decisions at high levels, and in the field of labor, which would be premature and certainly harmful to the progress of our production and services and therefore our national prosperity. Industry should orient itself with respect to automation before applying it in the measure which circumstances permit, so as to put itself in line with the reduction of costs of equipment, consumers' items and services which the advent of automation is bringing about in other, more progressive countries.

Never in the course of the industrial era has technological progress led to permanent unemployment, which is proved conclusively by recent American statistics. Rather, it has been, and will be in the future, a case of the shifting of labor from given technical activities to other productive or service functions, rendered necessary by industrial development itself. An example of this is the extraordinary evolution of automobile production which has given work and bread to millions of new workers who attend to all those services and accessory or secondary productive tasks which the automotive world has required and continues to require. This transition of labor especially towards so-called tertiary activities is an inevitable result of automatization which must be accepted as a reality. Another consequence of automatization, which is not to be made light of, is the absolute necessity of reclassifying labor, the level of which has to be raised rapidly in order to favor its reabsorption by other productive sectors and, possibly, to bring about a greater emigration of qualified workers.

Fear of Unemployment

We can never sufficiently emphasize that great prudence must be applied in dealing with the problem of labor in relation to automation. It is evident, in view of the rather high level of unemployment in Italy, that in the foreseeable future a heavy surplus of help due to the further expansion of automation can develop serious apprehensions in the population, in social organizations and last but not least in government circles. We must react energetically to such exaggerated fears and against preoccupations which are mostly unreasonable and influenced by demagogues. One-sided attitudes or provisions of a precipitous nature may develop into a national calamity.

We must bear in mind that in the near future the first to suffer by the lack of automation will be the workers themselves, because in the atmosphere of extensive international technological progress it will be primarily automation which will keep them employed, even though they will have to be reclassified as specialists. We must therefore persuade them that their fate is tightly connected with the prosperity of their employers and that only a climate of healthy and effective co-operation can ensure them economic advantages which would otherwise be precluded.

In the light of this it is certainly significant that after the events at Coventry the wiser section of the British press has clearly understood the extreme danger to national prosperity unless British automation were maintained at the level of international progress. If we may say so, the error there was that the necessary reclassification of labor and technological conversion, which should have been perfected well in advance of production expansion, had not been predicted and planned for early enough, when British automotive industry was not yet forced by necessity to reduce production costs in order to fight foreign and particularly American competition.

This example should prove that, in Italy too, it is necessary to concern ourselves with automation before it is too late. Evidently we cannot isolate ourselves within industrial immobility which shuts the door to world automatization. Such immobility would be unforgivable and could not be relieved even by the highest possible trade and customs barriers.

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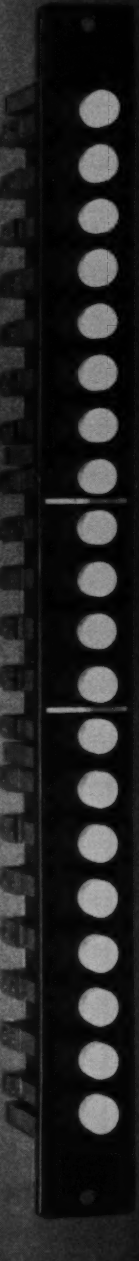

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Costs Must Go Down

It is obvious that the present social and economic positions are to be revised as a consequence of the advent of automation. But let us beware lest we kill the chicken before it has laid the egg. In other words, we must afford industry the time and the means to put automation into effect. Only then will it be possible to distribute its results taking the workers' legitimate rights into due consideration. We should therefore place the problem on the carpet in order to study the means to avoid harmful inequalities in industrial employment and make labor relations match the new economic and productive situations which will develop. The measures arrived at as a result of such study should not hamper in advance, however, the evolution of technical and scientific progress and the upgrading of labor's efficiency on the grounds of purposeless political arguments, which are far from being useful to collective interests.

Therefore, if we first attend to the solution of the structural problems of industry according to the dictates of automation, although we may at first note an upward trend in unemployment, we shall discover that such unemployment, as evidenced by American and European experience, cannot be but temporary for the above reasons. If, however, we do not allow industry the time and the means of reducing costs through automation, we would do nothing but increase unemployment since our industry, unable to resist foreign competition, would be forced to inactivity. The consequence is that the adoption of automation must be favored in all possible ways by the State. Only by maintaining the costs of production tools at competitive levels will it be possible to maintain at least the present level of employment.

Essence of Automation

Another misconception is that automatization is a recent development establishing one of the many industrial revolutions. This is not true. Automatization is gradually taking over production, at a rate which is variable and proportional to contingencies. Presently and for the past 10 years, it has undergone a most intense period, especially as a result of the adoption of more perfected automatic controls and servomechanism techniques.

For all technical peoples, Italians included, automatization is not a problem, the solution of which presents special difficulties, except perhaps at the integrating stage. More than a question of new types of machinery and tools, it will be a matter of reorganizing and integrating production cycles. And it is worthwhile to recall the fact here that automatization brings about simplification and not complication of any productive process.

How was present automation reached? Actually it is the result of an almost pathological expansion of the phenomenon of automatization during the 10-year period we spoke about. In fact it is not difficult to conceive that a completely new situation has been created by: The reduction of human activity in manufacturing which was formerly conceived as a function of personal ability, the concentration or rather the interconnection of formerly separate production cycles into one or several production lines, the high cost of integrated automatization with its heavy drain on capital, the standardization dictated by the high costs of too frequent production changes, the need to discover new outlets for products, the reclassification of help, the greater demand upon power supplies, the rapid obsolescence of tools and the indispensable reorganization of ad-

AUTOMATION
Ekarl

"He didn't get a chance to get away for his vacation this year!"

ministrative functions in industry.

Automation is therefore a new philosophy of production, born, if we may say so, from the strong trend towards increased production in recent times. It brings about to the fullest the co-ordination, the mutual integration and the constant matching of changing demand conditions with the capacity of the automatic production lines. It means exploiting even the most limited lots of similar products through the internal and external mobility of a type of highly qualified worker, and it can be said that automation methods clearly depart from the traditional ones which are not sufficiently rationalized on a nationwide or industrial level.

To cope with this a more elastic, analytical and creative managerial mind is required which should have imagination, far-sightedness and progressiveness much greater than the traditional one. Automation, in fact, calls for a revelation of optimism, of rebellion against traditionalism, creative ability, enterprise, leaning towards calculated risk and generally that freedom of initiative which is indispensable to industrial prosperity. If therefore on the one hand automation develops new energies in far-sighted and progressive managers, opening for them wider business horizons; on the other it is a challenge for all reluctant ones that prefer to take shelter in tranquil conformity, and fail to contribute to the progress and stability of national welfare. This modern system of appraising, organizing and controlling productive processes to attain the optimum exploitation of all productive, material, human and energy resources on a national scale, is what constitutes the essence of automation in modern times.

The Best in Life

In substance automation means a greater productive capacity and a reduction of the labors of the working man, who will have more time available, to the extent perhaps of three days off per week, as a result of the inevitable reduction of working hours. The use of this leisure time may represent one of the fundamental social problems deriving from automation.

Since higher wages and an improved purchasing power of money, which are among the foreseeable results of correctly planned automation, will enable workers to furnish their homes more carefully and comfortably and possibly permit them to purchase a house with some ground around it in the country, it is likely that a greater attachment to family life will develop. Also, radio and television shall be made available to the less wealthy, contributing to hold men within the confines of their homes during leisure hours. Of course it will be possible for all, according to their likings, to devote their time to the arts, culture, sports or some hobby. Social life will probably undergo a radical change and family institutions will become noticeably consolidated.

From a paper entitled "Some Aspects of Automation In Italy" presented in L'AUTOMAZIONE, Oct. 1956.

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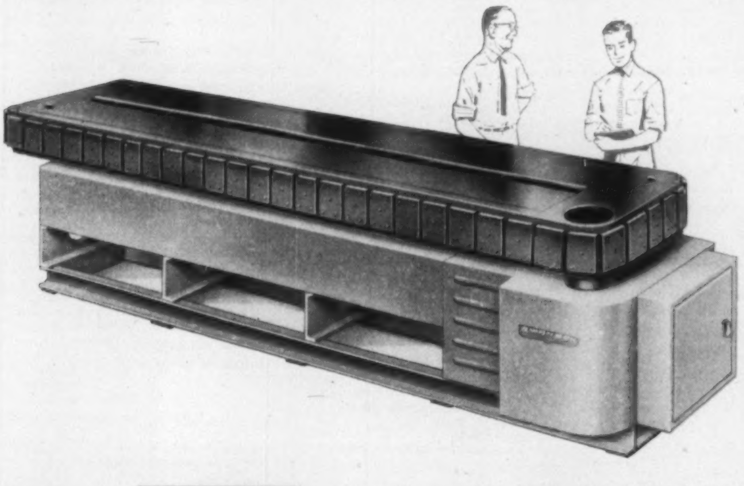

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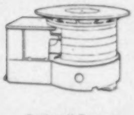

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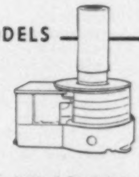

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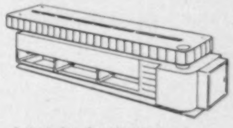

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Circle 618 on Inquiry Card

CUMULATIVE EDITORIAL INDEX

Including six issues. Number preceding the hyphen is month of issue; those following are page numbers in that issue.

A

Abruzzi, A.
  New Horizons in Labor Dignity, 12-38
Accessibility, electronic equipment, 2-73
Adhesive application, 1-9
Air, use of compressed, 9-43
Alodine processing, 12-65
Analog,
  information, 10-84
  systems, 10-137
Analysis,
  gas stream, 11-78; 1-14
  of production process, 2-46
Analyzers, acetylene, 1-127
Annealing, 1-68; 2-60
Anodizing, 12-65
Antonson, W. L.
  Photoelectric Control in Log Handling, 11-58
Application engineering, electronic equipment, 2-73
Assembly, 10-50
  auto wheels, 9-40
  automated, 10-50; 11-63; 12-55; 1-45, 60; 2-15
  automobile engine, 2-54
  circuit board, 10-68
  continuous, 11-63
  cyclic, 11-63
  electrical equipment, 2-46
  electronics, 10-19
Astin, A. V.
  Industry Needs Automation, 9-133
Automation,
  and labor, 12-38; 1-22; 2-9, 54
  and the public, 1-29
  and smaller plant, 10-63
  controllers, 9-54
  developments needed, 9-133
  economics, 1-40
  engineering aspects, 2-148
  evaluating for ,1-40
  history, 12-33
  in Britain, 2-39
  in Italy, 2-138
  machine tool field, 10-63
  organizing for ,1-51
  philosophy, 12-9, 38; 1-35
  planning for, 12-55; 1-40, 70
  small scale, 1-40
  social effects, 2-148
  welding field, 11-33
Automobile,
  manufacture, 1-29
  parts manufacture, 2-34
  wheel assembly, 9-40

B

Balancing,
  automatic, 9-71
Ballizing, 10-75
Batch formulating, 12-46
Batch processing, 11-81; 12-65; 2-60
Bearings, antifriction valve, 9-70
Bentley, H. R.
  Automated Engine Plant, 2-54
Berry, W. D.
  Progress In Stamping, 2-67
Black, D. V.
  Bibliography of Literature on Computers, 11-135
Bobbin winding, 12-43
Boiler water corrosion, 9-12
Bolz, R. W.
  Standing Still, edit., 2-45
Bonding linings, 11-78
Books on automation, 2-39
Brazing, 2-60
Briquetting, chips, 2-34
Broaching, 11-48
Brown, J. J.
  Potential in Canada, 10-142
Buffing, 1-68
Burgoyne, A. S.
  Synchronizing Sensing and Processing, 9-49

C

Canada, automation in, 10-142
Capacitors, ceramic, 12-19
Carrier equipment, remote control, 9-66
Casgrain, W. V.
  Materials Handling Trends, 11-126
Castings, 12-72
  continuous,11-129
Ceramics, firing, 2-70
Chemical,
  analysis, 11-25
  pneumatic & electronic controllers, 9-54
Chip handling systems, 2-34
Circuits,
  design, 11-131
  molded, 1-14
  preferred, 2-73
  telephone, 11-50
  triple coincidence, 1-12
Classification system, 12-48
Classifying, 12-67
Close, G. C.
  Pushbutton Metal Treating, 12-65
Coded descriptions, 12-48
Coining, 11-64
Communication, of technical information, 2-9
Components,
  electronic, insertion, 10-68
  preferred electronic, 2-73
Compressed air use, 9-43
Computers, 10-22, 137; 1-131; 2-148
  bibliography on, 11-135
  for design, 2-16
Computing, mix proportions, 10-62
Contents, 2-3
Continuous processing, regulators, 1-54
Continuous stream processing, 8-49
Contour forming,
  machining, 11-131
Control,
  bulk feeders, 12-60
  computers, 10-137
  conveyors, 11-58; 12-77; 1-127
  cutoff operation, 10-74
  digital, 9-130
  edge position, 1-54
  finishing process, 11-57
  flow ratio, 11-80
  food packaging, 9-46
  gas stream, 1-14
  grinding, 12-76
  grinding operation 12-46
  heat program, 2-60
  machine, 9-71
  machine tools, 9-12 130; 10-137, 11-73; 1-70
  memory system, 1-75
  meter-relay, 12-74
  moisture, 9-9
  motor speeds, 12-53
  numerical, 9-130; 10-84; 1-70; 2-53
  overhead crane, 9-10
  pH, 9-78
  photoelectric, 11-58; 1-75
  positioning motors, 11-71
  program, 2-60
  punched card, 11-81
  punched tape, 2-53
  rolling mill, 11-9
  speed, 10-90; 1-54
  system design, 1-54
  temperature, 10-78
  template, 11-73
  thickness, 10-90
  work handling, 1-120
Control-display relationships, 2-150
Controllers, 9-54
  moisture, 9-9
Conveying,
  newspapers, 10-59
  TV tubes, 2-79
Conveyors,
  chip, 2-34
  collapsible tube, 2-144
  control, 12-77
  escapment, 9-41
  overhead, 1-131
  plastic belt, 12-16
  plastic tube, 1-10
  transfer, 9-44
Corrosion, boiler, 9-12
Counter, for cutoff control, 10-74
Crane control, 9-10
Current limiting switches,1-65
Cycle, timers, 2-87

D

Data processing, 10-12, 62, 148; 11-9, 15, 16, 78; 12-12, 60, 132; 1-10
Data reading, 12-12
Data transmission, 12-137
Daugherty, J.
  Management and Numerical Control, 9-130
Definitions, technical, 12-141
Delays for information, 9-49
Delay timers, 2-88
Design,
  for automated production, 2-46
  for automatic stamping, 2-67
  hydraulic, 10-75
  of automatic sorter, 12-67
  of electronics for reliability, 2-73
  standardization, 12-48
Dialing, automatic, 12-14
Dickey, P. S.
  Instrument Control of Power Plants, 11-123
Die block hardening, 2-60
Digital,
  control, 9-130; 12-129
  display, 2-15
  encoder, 9-10; 12-60
  information, 10-84
  systems, 10-137; 2-10
Diodes, 2-150
Drafting machine, numerically controlled, 2-39
Drilling and tapping machines, 2-46
Drives, dc, 1-54
  variable speed, 1-54
Drum escapments, 2-80
Dust collection, 11-78

E

Economics, 10-68; 2-54, 138
Electrical,
  connection manufacture, 2-46
  measurements, 2-148
  standards, machine tool, 2-148
Electrode positioning, 10-90
Electrohydraulic systems, 10-88, 91
Electronics,
  assembly, 10-19
  circuit assembly, 10-68
  control, 9-54
  harness assembly, 1-12
  reliability of, in business, 2-148
Engineering for automation, 1-57
Engineering, production, 2-133
Engineers,
  processing, 11-33
  unionized, 2-24
  welding, 11-33
Equipment replacement, 1-122
Escapements, 10-50; 2-80
Evaluation for automation, 1-40

F

Facsimile reproduction, 11-10
Fastening, 10-50; 11-64
Feedback, 9-130; 10-137
  components, 2-19
Feeders, 10-50; 1-45
  escapements, 2-80
  press, 12-72
Feeding, 11-129
  assembly components, 10-50
  dry foods, 9-46
  grinder, 2-70
  into baskets, 2-10
Filling, cans, 1-61
Filling yarn preparation, 12-43
Finishing, 11-57
Flame hardening, 11-77
Flash removal, 10-83
Flow measurement, 10-20; 12-14
Flow ratio control, 11-80
Fluid heating, 2-60
Food packaging, 9-46
Forging, machining, 9-64
Formulation, 10-62
Freight car classification, 11-44
Furnaces, 2-60

G

Gaging, 2-54
  strip thickness, 11-25; 12-73
Gate escapments, 2-80
Geoghegan, R. S.
  Reduce Unnecessary Variety, 12-48
Glass cutting, 2-146
Greenley, H. R.
  Auto Wheel Assembly, 9-40
Grinding, 11-62; 12-64
  automated, 2-70
  control, 12-76

H

Handling, 11-129; 12-64; 1-68
  between presses, 1-118
  bulk materials, 11-81; 1-69
  chips, 2-34
  controls, 1-120
  conveying, 2-22, 79
  feeding, 10-50; 11-48, 62, 63; 1-127; 2-70
  for automated lathe, 10-83
  for pipe threading, 12-73
  for warehouse, 12-73
  in cartridges, 12-67
  in news plant, 10-59
  in packaging, 12-62
  logs, 11-58
  scrap, 1-69
  stone, 9-70
Hardening, 11-77
Harness assembly, 1-12
Heat processes, 2-60
Heat treating, 2-60
Heinz, W. B.
  Electrohydraulic Devices, 10-88
Henwood, J. B.
  Automating Batch Heat Processes, 2-60
Herchenroeder, L. W.
  Numerical Control of Machine Tools, 10-84
Hole finishing, 10-75
Host, J. A.
  Basic Transfer Machine, 10-91
Hydraulics, machine tool, 10-75

I

Inching for presses, 2-146
Indexing, 2-53
Industrial engineering, 12-141
Information, delays, 9-49
In-motion weighing, 11-44
Inserting, electronic components, 10-68
Inspection, 2-54
  high frequency current, 2-12
  photoelectric, 2-72
  x-ray, 2-72
Instruments, 9-22
  control, 11-123
Insulation removal, 2-66
Integrating automatic operations, 12-43
Interlocks, 1-127; 2-146
Irradiation control, 12-78
Italian automation, 2-138

J

Jaw-type escapments, 2-80
Joyce, A.
  Magnetic Memory Links Continuous Inspection and Sorting, 1-75

K

Kendall, G. H., Jr.
  Basic Transfer Machine, 10-91
Kendall, G. H., Sr.
  Basic Transfer Machine, 10-91
Kraft, W. C.
  Aircraft Skin Miller, 11-73

L

- Labor, 1-29; 2-54
- *Landsness, C.*
  - Automatic Balancing, 9-71
- *Lawson, A. A.*
  - Insertion of Electronic Components, 10-68
- Lead wire preparation, 2-66
- Legal problems, 10-148
- Level measurement, 12-16
- Limit switches, 1-65
  - rotary, 12-16
- Linear programming, 10-148
- Literature on automation, 2-39
- Load cell system, 11-44
- Load surveys, 11-15
- Lubrication, 1-10, 16; 2-22
  - automatic, 1-61

M

- Machine tools,
  - auxiliary equipment, 1-16
  - boring, 9-43
  - broaching, 11-48; 1-14
  - control, 9-12, 130; 10-19, 63, 84, 137; 11-73
  - conversion, 11-73
  - drilling, 1-40
  - drilling & tapping, 2-46
  - electronic erosion, 1-12
  - feed control, 2-144
  - hydraulic systems, 10-75
  - lathe, 11-12
  - lubrication, 1-10
  - numerical control, 1-70; 2-53
  - radial drill press, 2-53
  - skin milling, 11-73
  - tape control, 10-9
  - tapping, 2-46
  - tracer control, 11-131
- Machines,
  - adhesive applying, 1-9
  - assembly, 1-45
  - balancing, 9-71
  - food packaging, 9-46
  - grass growing, 12-22
  - indexing, 1-45
  - packaging, 1-61
  - potato dicing, 1-127
  - replacement policy, 1-122
  - scheduling, 2-150
  - sorting, 12-67
  - wrapping, 1-61
- Magnetic amplifiers, 10-14; 11-71; 12-53; 1-65; 2-87
- Magnetic memory units, 1-75
- Magnets, testing, 12-78
- Maintenance, 1-61
  - of electronic equipment, 2-73
- Management planning, 9-130; 1-40
- Manufacture of,
  - air frames, 1-70
  - ammunition, 2-72
  - automobiles, 1-29
  - automobile engines, 2-54
  - automobile floor panels, 2-67
  - automobile parts, 9-43; 12-33; 2-34
  - axle housings, 11-33
  - cigarettes, 2-144
  - circuit boards, 10-68
  - clad copper wire, 2-9
  - cloth, 12-43
  - electrical coils, 2-144
  - electrical connections, 2-46
  - flywheels, 9-71
  - motors, 1-60
  - paperboard milk cartons, 1-75
  - piston pins, 11-62
  - pistons, 9-43
  - quartz crystals, 12-67
  - razors, 1-45
  - tea bags, 1-61
  - television tubes, 2-79
  - terminal blocks, 2-46
  - valves, 9-64
  - windows channel, 1-19
- Manufacturing engineering, 2-46, 133
- *Mater, M. H.*
  - Photoelectric Control in Log Handling, 11-58
- Materials,
  - handling, 11-14, 126
- Measuring,
  - mass per unit length, 12-137
  - positioning control, 12-129
  - pressure, 2-12
  - web width, 2-146
- Memory circuits, 1-65
- Memory units, 11-16; 1-75
- *Menard, C. G.*
  - Hydraulic System Improvements, 10-75
- *Merchant, C. O.*
  - Assembling Razors Automatically, 1-45
- Metals,
  - surface treating of, 12-65
  - surface whisker growth, 2-10
- Meter-relays, 12-74
- Metering,
  - liquids, 11-80
  - molten metal, 12-137
- *Milek, J. T.*
  - Bibliography of Literature on Computers, 11-135
- Mixing, dry, 10-14
- *Moeller, L. J.*
  - Manufacturing Engineering At Work, 2-46
- *Mohler, J. B.*
  - Controlling pH of Process Solutions, 9-78
- Moisture controller, 9-9
- Molding, 2-144
- Motor,
  - speed control, 12-53
  - tape control, 10-19

N

- Newspaper handling, 10-59
- Numerical control, 9-130; 10-84; 12-129; 1-70; 2-39, 53
- Nut-setting, 11-65

O

- Operations research, 2-148
- Organizing for automation, 1-51
- Organizing for production engineering, 2-133
- Orienting mechanism, 12-67
- Orienting methods, 10-50
- Oscillating timers, 2-87
- Ovens, overhead, 1-69

P

- Packaging, 9-14; 11-78; 12-62; 2-146
  - appliances, 12-62
  - dry foods, 9-46
  - machines, 1-61
- Pallets, transfer, 10-91
- Parts selectors, 10-50
- Personnel, 2-54
- pH,
  - control of, 9-78
  - measurement, 9-12
- Philosophy,
  - automation, 12-38; 1-35
  - education, 11-20
- Photocell,
  - control, 11-58; 12-137; 1-75
  - temperature indicator, 10-78
  - weight indication, 12-60
- *Pick, M.*
  - Pulse Counter Controls Cutoff, 10-74
- Pilot lines, 2-46
- Planning, 1-40
  - for automation, 12-55; 1-40, 51, 70; 2-54
- Pneumatic,
  - controllers, 9-54
  - symbols, 12-141
- *Popoli, F. R.*
  - Applying Telephone Switches and Relays, 11-50
- Positioning, 10-50; 2-53
  - control, 11-71; 12-129, 139
- Presses,
  - automated, 12-72; 2-67
  - unloaders, 1-118
- Pressure measuring, by streaming potential, 2-12
- Printed circuits, 1-14
- Printing, 1-75
  - newspapers, 10-59
- Procedures, automation projects, 12-55
- Process,
  - analysis, 2-46
  - controllers, 9-54
  - design, 11-129
- Processing, chemical, 12-65
- Product engineering, 2-133
  - electronic equipment, 2-73
- Production engineering, 2-133
- Programming, 10-68; 2-60
- Project analysis, 12-55
- Proportioning, 11-80; 12-46
- Proximity limit switch, 1-65
- Pump, chemical resistant, 10-20
- Pumping, controlled volume, 12-141
- Punched cards, 10-68
  - batching control, 11-81
  - rolling mill control, 11-9
- Punched tapes, 1-70; 2-53

Q

- Quality control, 2-54

R

- Radial drill presses, 2-53
- Radio, civil defense, 10-9
- Railroad, car weighing, 11-44
- Random processes, control, 10-148
- Ratchet escapements, 2-80
- *Redner, K. H.*
  - Packaging Dry Food Products, 9-46
- Regulators, motor, 1-54
- *Reiter, R. E.*
  - Preparing for Numerical Control, 1-70
- Relays, electrohydraulic jet pipe, 10-88
  - electromagnetic, 1-131
  - telephone type, 11-50
- Reliability,
  - of electronic design, 2-73
- Remote control, 10-14
  - via voice frequencies, 9-66
- Reproduction, facsimile, 11-10
- Resistors, temperature sensitive, 9-69
- Reversing drive, 2-19
- Riveting, 11-64

S

- *Saint-Amour, P.*
  - Using Meter-relays, 12-74
- Sand preparation, 12-46
- Saturable reactors, 11-71; 12-53; 1-65
- *Scollard, W. E.*
  - Auto Wheel Assembly, 9-40
- Scrap, chip handling, 2-34
- Screwdriving, 11-65
- *Seidel, R. B.*
  - Tailoring Automation To Plant Needs, 10-63
- *Seifried, A. G.*
  - Regulators at Work, 1-54
- Semi-conductor, thermistor, 9-69
- Servosystem, 1-14
- *Sherman, D. W.*
  - Organizing for Automation, 1-51
- Simplification, 12-48
- *Slattery, T. G.*
  - Magnetic Memory Links Continuous Inspection and Sorting, 1-75
- Slide escapements, 2-80
- Small plant automation, 10-63
- Small plant research, 12-12
- *Smith, J. R.*
  - Electronic Reliability Can Be Designed-In, 2-73
- Smoothness indicator, 2-146
- Solution, pH controls, 9-78
- Sonic separation, 2-146
- Sorting, 11-12, 67, 129; 12-67; 1-75
- Speed, control, 12-53; 1-54
- Spinning, 11-65
- Spline broaching, 11-48
- Staking, 11-64
- Stamping, 2-67
- Standardization, 12-38, 48
  - tooling, 9-43
- Standards, 11-131
  - machine tool electrical, 2-148
- Statistics, automation, 10-143
- *Stone, J. J.*
  - Computers in Machine Tool Control, 10-137
- Stud-setting, 11-65
- *Sullivan, E. M.*
  - Assembling Razors Automatically, 1-45
- Supervision, 2-19
- Switches,
  - current limit, 1-65
  - electromagnetic, 2-24
  - proximity limit application, 1-65
  - telephone type, 11-50; 1-19
  - wattmeter, 1-65
- Systems, engineering, 1-131

T

- Tapes,
  - control, 10-9; 1-70; 2-53
  - recording, 11-15
- Telemetering, 12-137
- Telephone equipment, 11-50
- Television tube manufacture, 2-79
- Temperature, control, 10-78
- Template cutting, numerically controlled, 2-39
- Terminal block manufacture, 2-46
- Terminology, 12-48
- Testing, 2-46, 54
  - electronic components, 12-14
- Theory of games, 10-148
- Thermistors, 9-69
- Timers, 2-87
- Timing, 9-49
  - by conveyors, 2-79
- Tool design, 9-43
- Tracer control, 12-12
- Training, production engineers, 2-133
- Transducers, magnetic motion, 2-144
- Transfer machines, 9-64, 74; 10-91; 11-37, 63; 12-33
  - tooling, 11-15
- Transistors, 2-150
- *Treer, K. R.*
  - Automated Assembly, 10-50; 11-63, 12-55
  - Escapements for Automatic Equipment, 2-80
- Turning, 10-83

U

- Ultrasonic equipment uses, 2-12

V

- Vacuum melting, 12-72
- Variable speed drives, 1-54
- Vending, automatic coffee, 2-10
- Voice frequency carriers, 9-66

W

- *Waldron, A. J.*
  - Weighs the Advantages of Pneumatics for Process Control, 9-54
- *Walker, J. R.*
  - Applying Magnetic Amplifiers, 11-71; 12-53; 1-65; 2-87
- Weaving, 12-43
- Weighing, 11-44, 81; 12-60
  - bulk, 12-46
- Welding, 11-9, 33, 67, 78; 1-60
- *Welshenbach, C. D.*
  - Packaging Is a Production Problem, 12-62
- *West, R. K.*
  - Automatic Temperature Control, 10-78
- *White, F. F.*
  - Developing Small-Scale Automation, 1-40
- Wire stripping, 2-66
- *Wise, L. V.*
  - Special Automatic Sorter, 12-67
- Work morality, 12-38
- Wrapping machines, 1-61
- *Wright, W. O.*
  - Maintenance Improves with Automatic Lubrication, 1-61

X

- X-Ray inspection, 2-72

Z

- *Zilius, R. B.*
  - In-motion Weighing, 11-44

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AUTOMATION patents

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AUTOMATIC MOLDING APPARATUS

Phonograph record manufacturing apparatus places a label on each mold platen, applies the moldable material between the platens, closes the mold and performs a timed cycle of heating and cooling operations, opens the mold, transfers the record to a second station and performs finishing operations. Patent 2,743,478 by Loraine C. Harlow, and Quincy E. Smith, assigned to Radio Corp. of America.

PROCESS FOR MANUFACTURING ELECTRICAL COILS

Sheets of insulating material with a pattern of conductive material on their surfaces are stacked to form a laminated structure. Patent 2,745,170 by Paul T. Nims, assigned to Chrysler Corp.

AUTOMATIC FEED CONTROL APPARATUS FOR MACHINE TOOLS

A strain sensitive element operated by deflection of the backup for a saw member adjusts the speed of the prime mover. Patent 2,754,567 by Robert L. Crane, assigned to Continental Machines Inc.

METHOD OF TRANSPORTING FINELY COMMINUTED SOLIDS

Finely comminuted solid is transported by aerating and pumping it into one end of a collapsible tube while applying suction to the other end with a pump operated at a volumetric rate in excess of the input unit. Patent 2,755,143 by Marion M. Cunningham, assigned to U.S. Rubber Co.

MAGNETIC MOTION TRANSDUCER

Transducer provides an electrical signal related in amplitude to the position of a magnet. Patent 2,755,403 by John S. Hickey Jr., assigned to General Electric Co.

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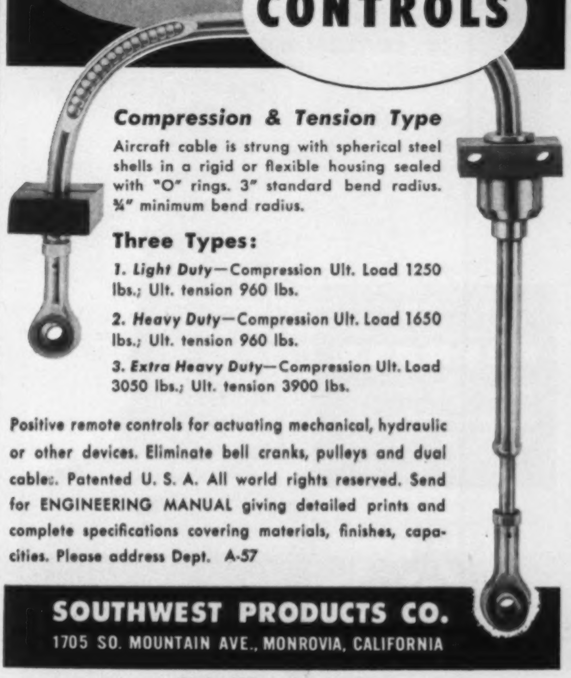

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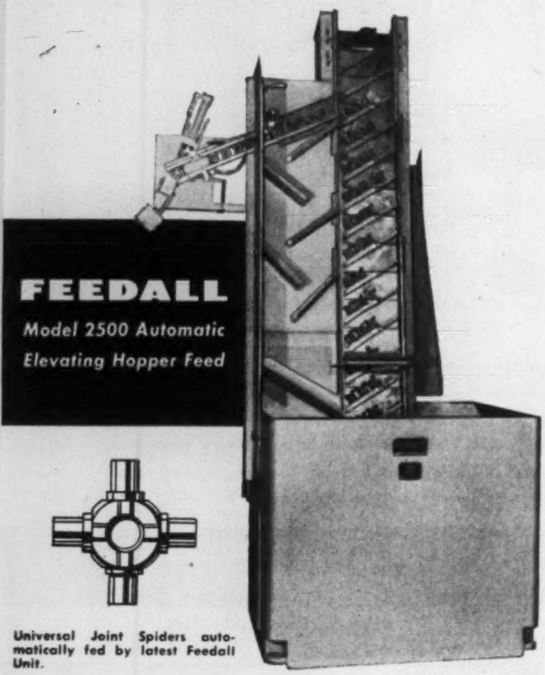

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the wheel, and depositing the composite rod on a discharge conveyor. Patent 2,742,907 by Hyman Policansky, assigned to Industrial Machinery Co. Ltd., London, England.

MOLDING PLANT

A pallet with base section and hinged lid is carried through a molding plant by a carriage on a conveyor. Patent 2,755,505 by Leonard J. Bishop, assigned to Mechanical Handling Systems Inc.

INCHING ASSEMBLY FOR POWER PRESSES

With the driveshaft of the press immobilized with respect to the brake housing, the brake housing can be rotated to inch the press. Patent 2,755,687 by James C. Danly, assigned to Danly Machine Specialties Inc.

SMOOTHNESS MONITORING DEVICE

Indication of the smoothness of a surface is given by a system based on a light source, magnifying means and photoelectric cell producing electrical signals indicative of surface smoothness. Patent 2,755,702 by Ellsworth D. Cook, assigned to General Electric Co.

METHOD AND APPARATUS FOR SONIC SEPARATION OF MINERALS

Pelletized material is separated into graded weights by deflecting lighter pellets from their free falling gravitational path under the influence of sonic waves. Patent 2,755,927 by George C. Brooks.

AUTOMATIC GLASS CUTTING MACHINE

A continuous sheet of glass is cut by a device which places the glass under compression, scores it, and applies tension, Patent 2,756,545 by Florian V. Atkeson, assigned to Pittsburgh Plate Glass Co.

APPARATUS FOR HANDLING PACKAGES

Packages moved by a conveyor means in a plurality of rows and files are inserted into successive empty cartons moving on another conveyor means. Patent 2,756,553 by John L. Ferguson and Richard C. Talbot, assigned to J. L. Ferguson Co.

WEB WIDTH MEASURING DEVICE

Device for gaging width of a traveling continuous web includes two scanning nozzles under vacuum and shifting means in a state of balance when the orifices are covered to a predetermined extent. Patent 2,756,586 by Roy W. Nash, assigned to E. I. du Pont de Nemours & Co.

INTERCHANGEABLE INTERLOCKING MECHANISM FOR ELECTRIC SWITCHES

Interlocking mechanism mechanically prevents movement of one switch until the other is fully in a desired position. Patent 2,756,612 by Harold E. Schleicher, assigned to Arrow-Hart & Hegeman Electric Co.

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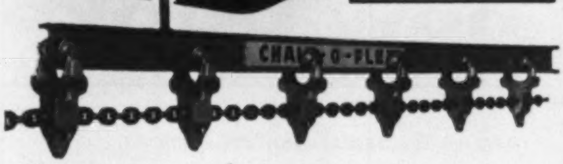

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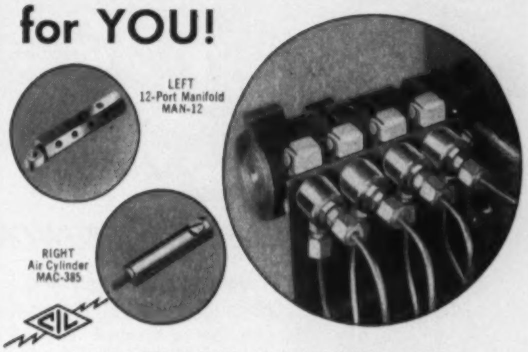

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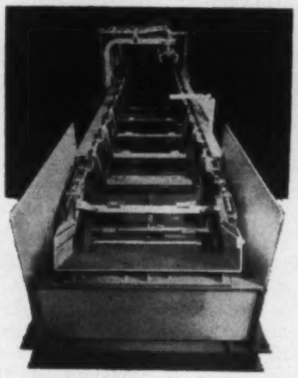

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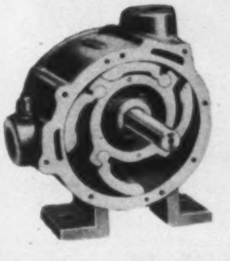

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By Isaac F. Kinnard, manager-engineering, Instrument Dept., General Electric Co., with 14 contributors; 600 pages, 5¾ by 9 inches, illustrated, clothbound, published by John Wiley & Sons Inc., New York; available from AUTOMATION; $15.00 *postpaid.*

Comprehensive text covers types of measurement equipment applicable to industrial use. Part 1 of the book deals with measurements of electrical quantities and Part 2 covers measurements of nonelectrical quantities such as light, heat, sound, static and kinetic effects, quantities and properties of liquids and gases, and time. Background material presented includes definitions, history, theory and bibliographies at the ends of chapters.

OPERATIONS RESEARCH FOR MANAGEMENT—VOL. II

Edited by Joseph F. McCloskey and John M. Coppinger; 563 pages, 6 by 9 inches, clothbound, published by Johns Hopkins Press, Baltimore, Md.; available from AUTOMATION; $8.00 *postpaid.*

Following up the general introduction of the subject in Vol. I, this volume details actual case histories showing operations research in use, methods, and discussion of information handling in organized groups. The work of about 30 authors is represented in this text. Additional references and a 15-page bibliography on Queueing Theory are also included.

THE PUSHBUTTON WORLD

Edited by E. M. Hugh-Jones; 158 pages, 5¼ by 8 inches, clothbound, published by University of Oklahoma Press, Norman, Okla.; available from AUTOMATION; $3.75 *postpaid.*

Based on a series of lectures at the University of Oxford, England, this book presents a broad view of automation, its scientific basis, aspects in engineering production, administrative applications, and social aspects. The lectures were delivered by leading English figures including Frank G. Woollard, R. H. Macmillan and the Earl of Halsbury.

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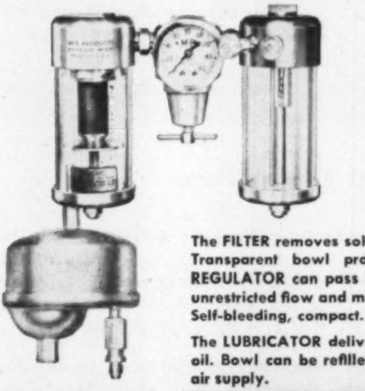

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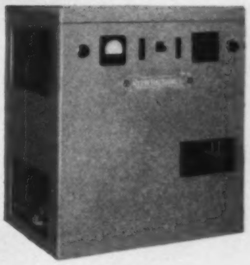

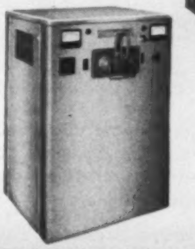

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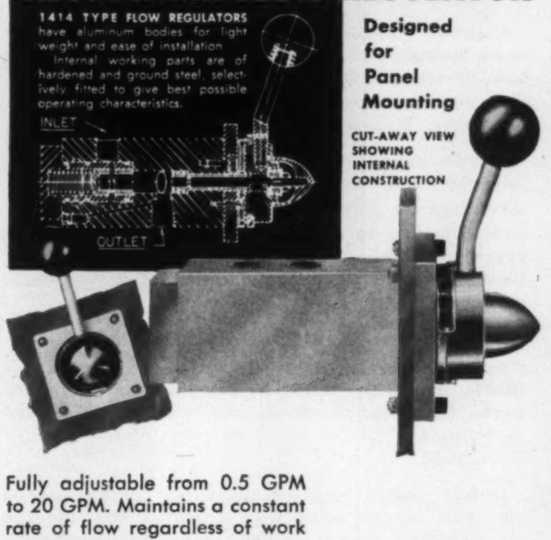

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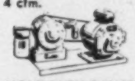

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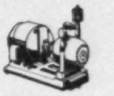

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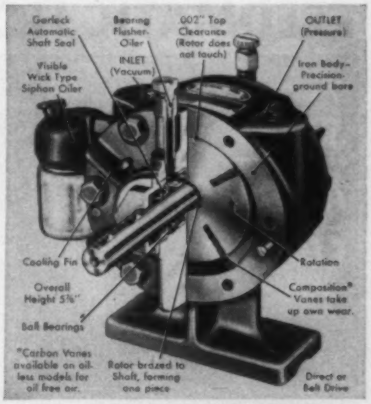

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plications, commercial computing centers, available data processing equipment, visual educational presentations, periodicals, reports and books dealing with business electronics. This report is complete in itself except that references to articles in publications only cover Jan. 1 through July 15, 1956, updating references in the preceding two volumes.

MACHINE TOOL ELECTRICAL STANDARDS

Paperbound, 44 pages, 8½ by 11 inches; available from National Machine Tool Builders' Association, 2071 *E.* 102*nd St., Cleveland* 6, *O.; By request.*

Revised in 1956, this version of electrical standards for machine tools covers recommendations approved by the NMTBA to make machine tools safer to operate, more productive and less costly to maintain.

Government Publications

Electronic Scheduling Machine Requirements. *Report* PB 121117 *by R. B. Canning, University of California, 43 pages, available from Office of Technical Services, U. S. Dept. of Commerce, Washington* 25, *D. C.;* $1.25.

How electronic computers can be used to aid production managers determine shop schedules is discussed. Investigations into the feasibility of applying computer technology to shop scheduling, ways of applying it, requirements in equipment and methods, and desirable computer characteristics are described. Illustrative times and costs based on one plant are presented.

Desirable Control-Display Relationships For Moving-Scale Instruments. *Report* PB 111649 *by Aero Medical Lab., Wright Air Development Center, 26 pages, available from Office of Technical Services, U. S. Dept of Commerce, Washington* 25, *D. C.; 75 cents.*

Summarizes a series of experiments designed to investigate the effects of certain control-display relationships on making settings with moving-scale instruments and to find the optimum relationship between control and moving-scale display. Recommendations are given for the application of moving-scale assemblies.

Industrial Preparedness Study of Transistors and Diodes. *Report* PB 121291 *by General Electric Co., 402 pages, illustrated, available from Office of Technical Services, U. S. Dept. of Commerce, Washington* 25, *D. C.;* $8.00.

Report covers technical advances for the period 1952-1955 in the production of germanium and the semiconductor devices in which it is used. Among developments discussed are: A continuous reduction furnace with an output equal to that of nine batch type furnaces; a resistance type pulling furnace adaptable to partial automation; a rectifier package designed for automatic, all-welded machine production; control of electrolytic etching made possible by an automatic machine; and increased production of high-voltage junction rectifiers by use of a tunnel oven diffusion process.

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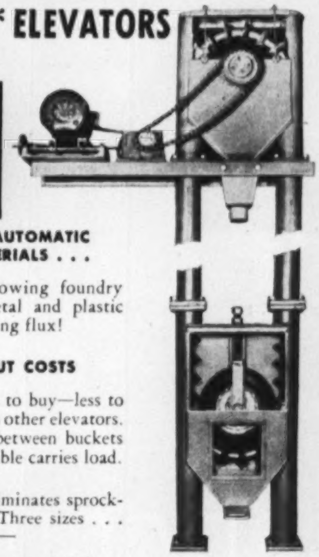

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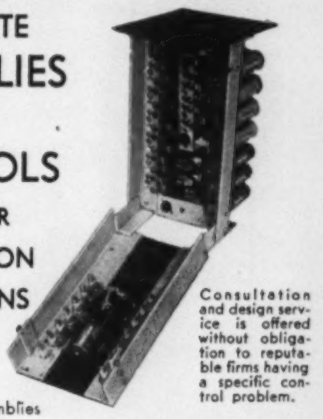

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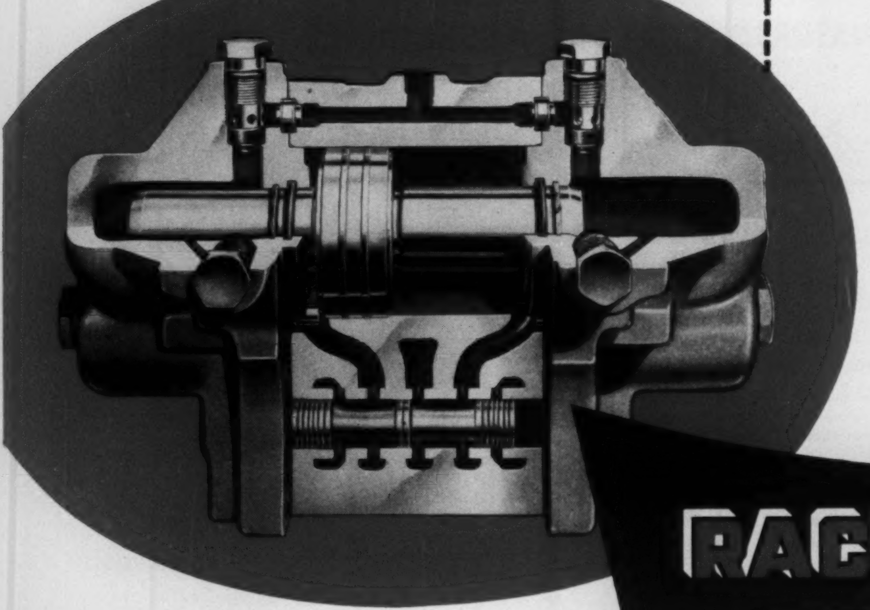

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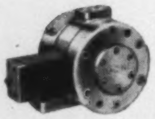

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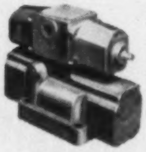

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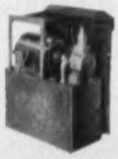

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ADVERTISING INDEX

Allen, A. K., Co. 42
Alvey-Ferguson Co., The 112
Arter Grinding Machine Co. 121
Askania Regulator Co. 13
Assembly Products, Inc. 153
Automation Devices, Inc., Perry Equipment & Engineering Co. Division 32

Baldor Electric Co. 117
Beckett-Harcum Co., Inc. 150
Bellows Co., The 132
Bell Telephone Laboratories 90
Black & Webster, Inc. 148
Bliss, E. W., Co. 25
Buckeye Tools Corporation 119

Chain-O-Flex Corporation 147
Clark Controller Co. 2
Cleveland Tramrail Division, The Cleveland Crane & Engineering Co. 43
Clippard Instrument Laboratory, Inc. 147
Composite Forgings, Inc. 147
Cutler-Hammer, Inc. Back Cover

Dearborn Gage Co. 29
Detroit Power Screwdriver Co. 114
Dexter Folder Co. 102

Electro Devices, Inc., Servospeed Division 103
Electrons, Inc. 139
Enterprise Machine Parts Corporation, The 131

Farval Corporation, The 95
Federal Products Corporation 6, 7
Federal Tool & Manufacturing Co. 145
Feedall, Inc. 146
Feedmatic-Detroit, Inc. 150
Ferguson Machine Corporation of Indiana 11
Flick-Reedy Corporation, Miller Fluid Power Division 34
Freed Transformer Co., Inc. 153
Fuller Co. 38

Garrison Machine Works, Inc. 24
Gast Manufacturing Corporation 149
Gemco Electric Co. 23
General Dynamics Corporation, Stromberg-Carlson Division 140
General Electric Co. 20, 21
Gray Equipment Co. 135
Greenlee Brothers & Co. 115

Hagen Manufacturing Co., Inc. 101
Hannifin Corporation 1
Hapman Conveyors, Inc. Division of Hapman-Dutton Co. 151
Hapman-Dutton Co., Hapman Conveyors, Inc. Division 151
Hinde & Dauch, Subsidiary of West Virginia Pulp & Paper Co. 123
Hobbs, John W., Corporation 105
Hunt, C. B., & Son, Inc. 125
Hydraulic Press Manufacturing Co., The 16

Illinois Tool Works, Shakeproof Division 5

KDI Corporation 128
Kingsbury Machine Tool Corporation 28

Lansing Stamping Co. 151
Leiman Bros., Inc. 147
Logan Co. 26

McGill Manufacturing Co., Inc. 44
McKay Machine Co., The Inside Back Cover

M-B Products 149
Malco Tool & Manufacturing Co. 116
Markem Machine Co. 138
May-Fran Engineering, Inc. 126, 127
Mechanical Air Controls, Inc. 14, 15
Metzgar Conveyor Co. 145
Micro Switch, A Division of Minneapolis-Honeywell Regulator Co. 36, 37
Miller Fluid Power Division, Flick-Reedy Corporation 34
Minneapolis-Honeywell, Boston Division 8
Minneapolis-Honeywell Regulator Co., Micro Switch Division 36, 37

Ortman-Miller Machine Co. 99

Packmaster Sales Co. 145
Perry Equipment & Engineering Co. Division of Automation Devices, Inc. 32
Peters-Dalton, Inc. 27
Pioneer Engineering & Manufacturing Co., Inc. 134
Pneu-Trol Devices, Inc. 144
Post Machinery Co. 118
Potter & Brumfield, Inc. 22
Pratt & Whitney Co., Inc. 96, 97

Racine Hydraulics & Machinery Co. 152
Radio Corporation of America 122
Ransburg Electro-Coating Corporation 111
Reeve Electronics, Inc. 149
Reeves Pulley Co. Division of Reliance Electric & Engineering Co. 137
Reliance Electric & Engineering Co., Reeves Pulley Division 137

Sensory, Inc. 151
Servospeed Division of Electro Devices, Inc. 103
Set Screw & Mfg. Co. 124
Shakeproof Division, Illinois Tool Works 5
Sheffield Corporation, The 106
Southwest Products Co. 145
Standard Conveyors 120
Stromberg-Carlson, A Division of General Dynamics Corporation 140
Swanson-Erie Corporation 141

Taft-Peirce Manufacturing 89
Tomkins-Johnson Co. 109

U.S. Engineering Co. 148

Waterman Engineering Co. 149
Wean Equipment Corporation Inside Front Cover
Westinghouse Electric Co. 40, 41

Yoder Co., The 19

Consulting Engineers' Service 154

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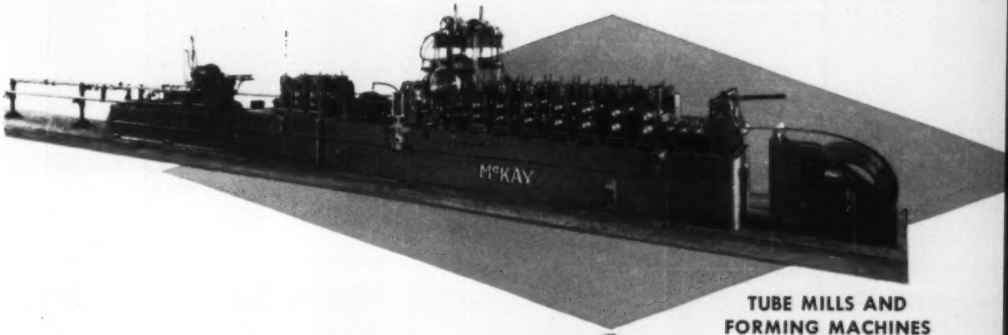

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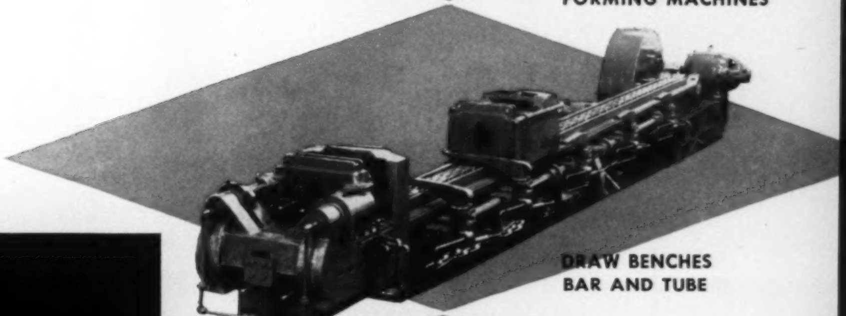

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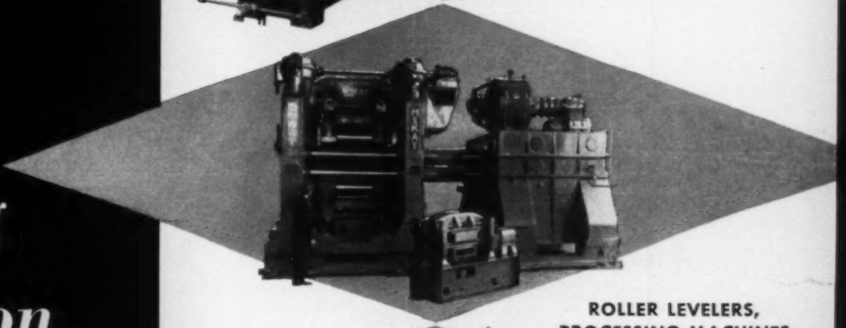

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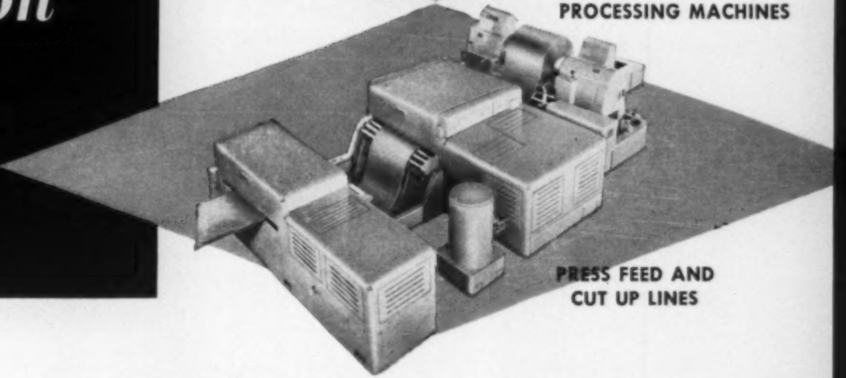

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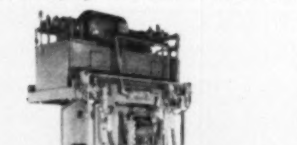

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